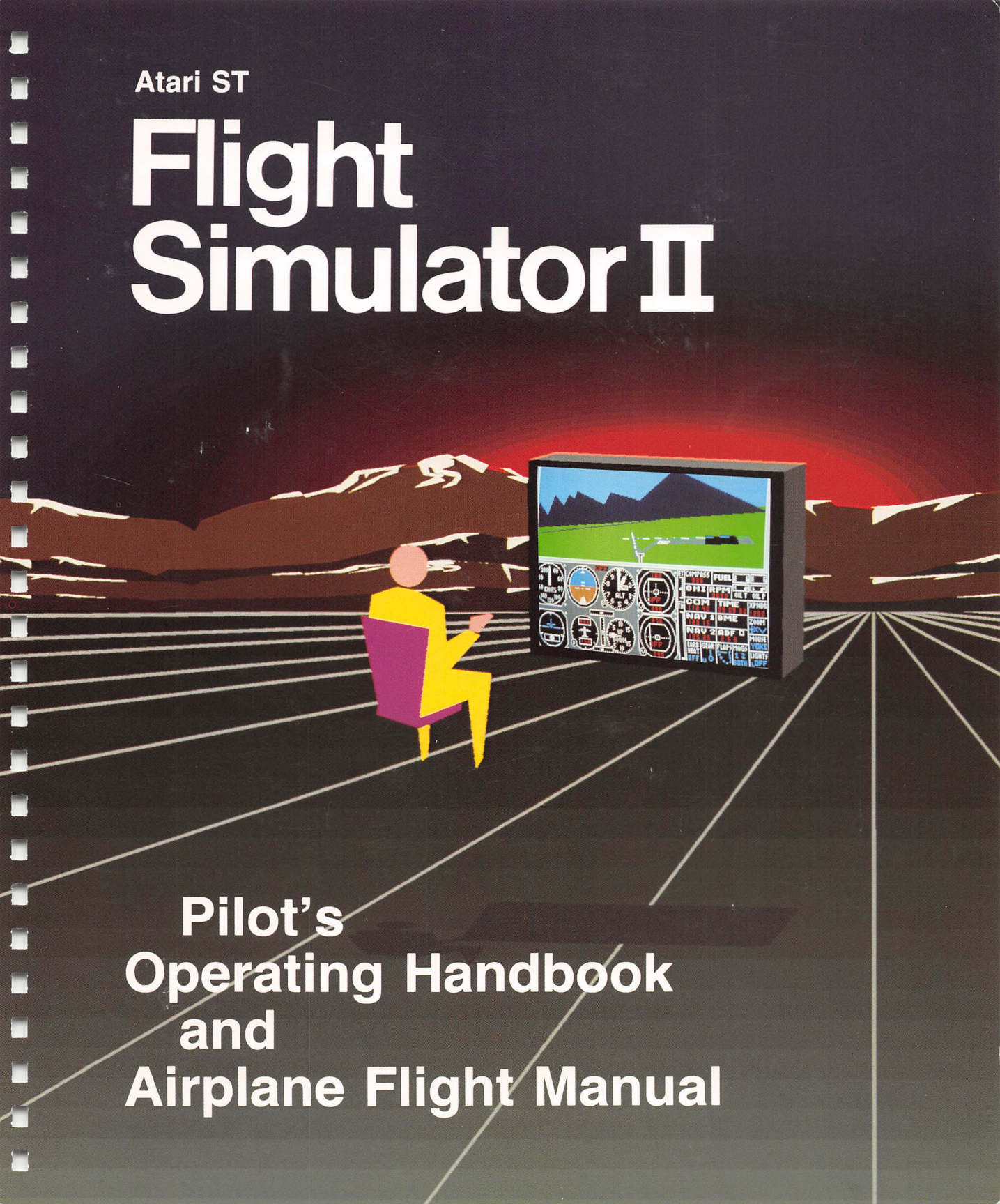
Atari ST

Flight Simulator II



Pilot's Operating Handbook and Airplane Flight Manual

FLIGHT SIMULATOR II
FOR THE ATARI ST

By Bruce Artwick & Mike Kulas

Program Number ST-FS2

SubLOGIC Corporation

First Edition
First Printing

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INTRODUCTION

Welcome to the Flight Simulator II microcomputer-based flight simulator. This simulator runs on the Atari ST computer with single floppy disk drive. It offers aircraft flight simulation that considers 47 important aircraft characteristics and provides multiple window out-the-window and control-tower views using a 3D flight display. Extensive flight controls (accessible using the mouse or keyboard) and minimum VFR and IFR instrumentation as specified by the FAA are displayed in a movable window.

Flight Simulator II features detailed graphics that closely simulate a pilot's actual perspective. The "68000 Precision Graphics Driver" presents solid-modeled images with hidden surface elimination and surface shading with much greater accuracy than any previous microcomputer Flight Simulator. The world is more than 10,000 by 10,000 miles square with a resolution of about one one-hundredth of an inch.

Flight Simulator II simulates two types of aircraft: a single engine, high performance, propeller driven aircraft of the Cessna 182 class, and a business jet of the Gates Learjet 25g class. The Cessna 182 type single engine prop aircraft is an ideal plane for pilot training because it has climb performance and speed that keep a pilot busy, especially on landing approach. The plane is slightly superior to an advanced World War I fighter. This aircraft's simulation is designed for realism and presents the feeling of flying this particular aircraft in a real-life situation.

The business jet simulation is designed more for fun than realism. The aircraft is very easy to fly, is quite aerobatic, and lets you see what it is like to fly at 450 knots and 50,000 feet altitude.

Flight Simulator II will help you learn about flight. It is not, however, a substitute for a flight training course. If you want more information on learning to fly, we recommend that you read the *Flight Training Handbook* published by the FAA, or check with your local airport for information about certified flight training courses.

FLIGHT TRAINING AND TRAINING AIDS

Flight Simulator II is useful in many flight training areas (navigation, visual orientation, and illustration of flight fundamentals). Although the simulator is entertaining and flies surprisingly like a real airplane, there is no substitute for a good flight training course that includes ground school and flight time in real aircraft.

The regulations regarding the logging of simulated instrument approaches (for general aviation under FAA Regulations Part 61.57) are hazy. SubLOGIC is pursuing the topic of acceptance and approval by the FAA (perhaps with the addition of flight-control hardware).

This manual explains flight simulator behavior and basic flying techniques. It is not a thorough flight instruction course. Further training handbooks and maps will be very helpful, especially for the novice pilot. Flight manuals and maps are available at FBOs (Fixed Base Operators) or flight training schools at most airports. They may also be obtained directly from mail order suppliers such as Sporty's Pilot Shop, Clermont County Airport, Batavia, Ohio 45103, (513) 732-2411. The following publications are recommended:

For the novice pilot with no manuals yet:

Flight Training Handbook. Latest revision. U.S. Department of Transportation, Federal Aviation Administration.

Aviation Fundamentals. 6th Edition. Jeppesen Sanderson, Inc.

Instrument Flying Handbook. Latest revision. U.S. Department of Transportation, Federal Aviation Administration.

For all pilots:

Airman's Information Manual. Latest edition. Aero Publishers Inc.

Seattle Sectional Aeronautical Chart

Los Angeles Sectional Aeronautical Chart

New York Sectional Aeronautical Chart

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Chicago Sectional Aeronautical Chart

San Francisco Sectional Aeronautical Chart

RUNNING THE PROGRAM

Before delving into aircraft controls and instrumentation, it's a good idea to get the simulator running. The startup procedures will be covered now.

SYSTEM REQUIREMENTS

You will need the following:

1. An Atari ST computer with at least 512K of memory.
2. A mouse.
3. A color or monochrome monitor. (Note: Separate versions of FS2 are required for use on the color monitor or the monochrome monitor. The version which works on a color monitor will not also work on a monochrome monitor. Make sure that the FS2 program you are running matches your monitor type.)

BOOTING THE DISK

1. Turn the Atari ST power on.
2. Insert the Flight Simulator II disk. Flight Simulator II will load automatically.

AUTO-DEMO

If no mouse movement is detected within 30 seconds after loadup, Flight Simulator II automatically goes into quiet demo mode. Get out of auto-demo by clicking the mouse. The DEMO RESET window will appear. Click the CLOSE box in the upper left corner of the window and press [P] to fly the aircraft.

ONLINE-HELP

Instrument and control functions are documented on-disk. Information about aircraft types and program updates can be found under the INFO menu on the menu bar.

Information about flight instruments and menu bar items can be selected by pressing the [Help] key. The cursor will turn into a "question mark" pointer. Point to items on the instrument panel or menu bar and press the left mouse button. If information for the selected item is available, a dialog box with the information will appear. Click the CLOSE box to turn off the message.

A QUICK TEST FLIGHT

The following steps are presented to get you flying as quickly as possible. This procedure gives an idea of what the simulator is all about and satisfies the urge to take the plane out for its first flight without reading the airplane flight manual first.

1. Turn the Atari ST computer on and insert the Flight Simulator II disk.

2. You are now on runway 27 Right at Oakland International Airport. A cursor should be present on the screen. Point the cursor anywhere on the 3D out-the-windshield view and press the right mouse button. Don't move the mouse after this click. The mouse is now in control yoke mode.

3. Press the [H] keyboard key to look out the right side of the airplane. You should see a mountain range off in the distance.

4. Press [F10] two times to zoom in and get a closer look.

5. Press [F9] two times to zoom back out.

6. Press [N] to look out the right rear. Part of the runway and Mount Diablo are visible.

7. Press [F] to look out the left window.

8. Press [T] to revert to front view.

9. Now, being careful not to move the mouse before pressing a button, press the left mouse button down and drag the mouse about 6 inches forward with the button held down. This will give you full throttle.

10. Release the left mouse button and move the mouse backward about an inch. This will give a bit of "stick back", or up elevator. The plane should take off by itself. You'll be able to see when you leave the ground.

11. Press [B] for a rear view as you climb out.

12. Press [T] for a front view again.

13. Press the right mouse button. A cursor will appear. Click on the menu bar items at the top of the screen to see the sort of menu options available, but don't choose any options at this time. Click anywhere off of the active menu to erase all menu boxes.

14. Point the cursor at the 3D screen and press the right mouse button to put it back into control yoke mode.

15. Move the mouse about an inch to the right. The airplane will start to bank.

16. When you attain about 20 degrees of bank, move the mouse about an inch to the left. This should stop the banking increase.

17. Watch the scenery as the plane turns. By this time you may be in range of the Oakland Bay Bridge or even downtown San Francisco.

18. Now, move the mouse about 3 inches to the left and leave it there for a minute or two.

19. After a crash, Flight Simulator II resets and returns you to your starting location.

ATARI ST STANDARD CONVENTIONS

In order to provide additional useful functions, a few standard Atari ST conventions were followed. If you are a frequent Atari ST user, these conventions should be quite familiar to you already.

Mouse Clicks
Items are selected using the left mouse button as usual. The menu system doesn't act exactly like a standard Atari ST menu, especially in the way menu items are not highlighted when a mouse cursor passes over them. To select items, simply point at them and click the left mouse button. Don't be concerned with highlighting.

Keypress Entry
A few standard Atari ST keypress conventions are used. For example, when entering text in a window, the [cursor up] and [cursor down] keys can be used to select items. The text entry cursor comes up at the beginning of the line. Use the [cursor left] and [cursor right] keys to move to the character you want to change. Use the [Delete] key to delete characters at the cursor position, or [Backspace] to delete characters to the left of the cursor. New numbers may be entered either from the keypad or the keyboard. After changing an item, press the [Return] key to enter it.

Window Control
Windows and dialog boxes often have SIZE boxes and CLOSE boxes. These are used to vary the size of the window and to specify that you are through making selections respectively.

ATARI ST STANDARD DIFFERENCES

Some aspects of Flight Simulator II don't follow Atari ST standard conventions.

More than one window can be active at a time. The Map, 3D, and control panel window, for example, can all be active at once. The Map and 3D windows may overlap each other, and may be overlapped by any of the various menus, but nothing may overlap the control panel. If you want to have a full-screen 3D out-the-windshield view, you must first slide the control panel window out of the way.

The right mouse button may be single-clicked in place of a left button double-click. This can be useful when the cursor is overlapping the instrument panel, in which case double-clicking is not recognized.

FILE SELECTION

Flight Simulator II has four flight modes and two demonstration modes:

PROP:	A single engine prop-driven aircraft.
JET:	A business jet.
WWI ACE:	A World War I dogfight game.
MULTI PLAYER:	A mode that allows you to connect two computers (using a cable or modems) and fly two planes together.
DEMO:	A demonstration program that self-flies the plane.
QUIET DEMO:	Performs the demo with all sound turned off.

(NOTE: If you start Flight Simulator II but don't move the mouse within 30 seconds, the program automatically goes into QUIET DEMO mode. You can stop this auto-demo by clicking the mouse button. The cursor will appear on the screen, and you can then select an operating mode from the FILE menu.)

Flight Simulator II begins in PROP mode, so there will be a check mark beside it.

The FILE menu also includes several options which are settable for any mode:

ORIENTATION MARKER:	Determines whether the orientation marker will be displayed.
TITLES ON WINDOW:	Determines whether identifying title bars will appear at the top of 3D and Map windows.
ASPECT RATIO LOCK:	Determines whether the field of view of 3D windows will change dependent upon the horizontal and vertical size of the window, or will remain constant.
SHADER:	Determines whether objects such as buildings, aircraft, and water will be shaded or just outlined.

Depending on the current mode, any of these items might be check-marked.

FLIGHT INSTRUMENTS, RADIOS, AND VISUAL SYSTEMS

Flight Simulator II has all the instruments and equipment required under FAA regulations (part 91.33) for day and night Visual Flight Rules (VFR) and day and night Instrument Flight Rules (IFR) under non-icing conditions.

This program follows the Atari ST computer's general philosophy of window, cursor, and mouse interaction. A few new concepts such as using the mouse as a control yoke as well as a cursor control must be learned, but generally, if you're familiar with using the Atari ST, you will feel right at home using Flight Simulator II. This section describes the instruments, radios, and windows so that you will recognize them when they appear. The next section (AIRCRAFT CONTROLS) gets into how to interact with the windows and fly the plane.

Windows are used for all Flight Simulator II displays. Figure 1 shows the most basic display configuration using a color monitor. Figure 1a shows the same configuration using a monochrome monitor. The instrument panel on the monochrome monitor is more detailed due to the higher resolution, but the color and monochrome panels are functionally equivalent. In addition, there are slight differences in the appearance of some menus, but all features are available on both machines.

MENU BAR

The menu bar at the top of the screen presents options used to control the simulation. To select an item, position the cursor on the menu title and click the mouse button. Move the cursor down to the command you wish to select and click again. This second click will both select your option and cause the menu to go away. If you decide to not choose any command, click anywhere outside the menu and the menu will go away. The menu items form the following command categories:

INFO: Information about Flight Simulator II, aircraft specs, and program updates.

FILE: Select a major operating mode (WWI ACE or DEMO for example). Also used to select display characteristics and to quit the program.

VIEW: Selects between COCKPIT, TOWER, TRACK, and SPOT view. Keyboard keys are more convenient for these functions and are specified on the VIEW menu.

ENVIRO: Seasons, clouds, wind, and other environmental factors can be altered. These are features external from the aircraft.

SIM: Simulation factors that are internal to the aircraft and simulation system are adjustable. These include reliability, pause, and sound.

NAV: Navigational factors including your location in the world are adjustable. The map display is also activated using this menu.

SITUATION: You can begin flight in a set of canned situations, or you can capture and save your own situations using this menu.

Specifics of these menu options are described in later sections.

THE THREE-DIMENSIONAL DISPLAY

The window that usually occupies the top half of the display screen is the 3D display (see Figure 1). This is the view out your windshield, your side windows, or from the control tower depending upon which view you select. The title bar on top of the window tells the view mode. Through this window you can see the runway, terrain, and horizon. You can also see the airplane you are flying if you have tower or spot view selected.

The visual effects of the Flight Simulator II program are realistic. Solid shaded surfaces give the feeling of depth and substance. Cloudy days bring dark skies unless you break out of the clouds and reach blue sky. As you fly through the clouds, visibility is obscured. At night, lights on the ground are your only visual reference.

At the bottom center of the 3D screen is the "center orientation marker". Pilots judge the attitude of their aircraft by the relationship of the airframe to outside visual references. The 3D display is a variable-sized window (notice the SIZE

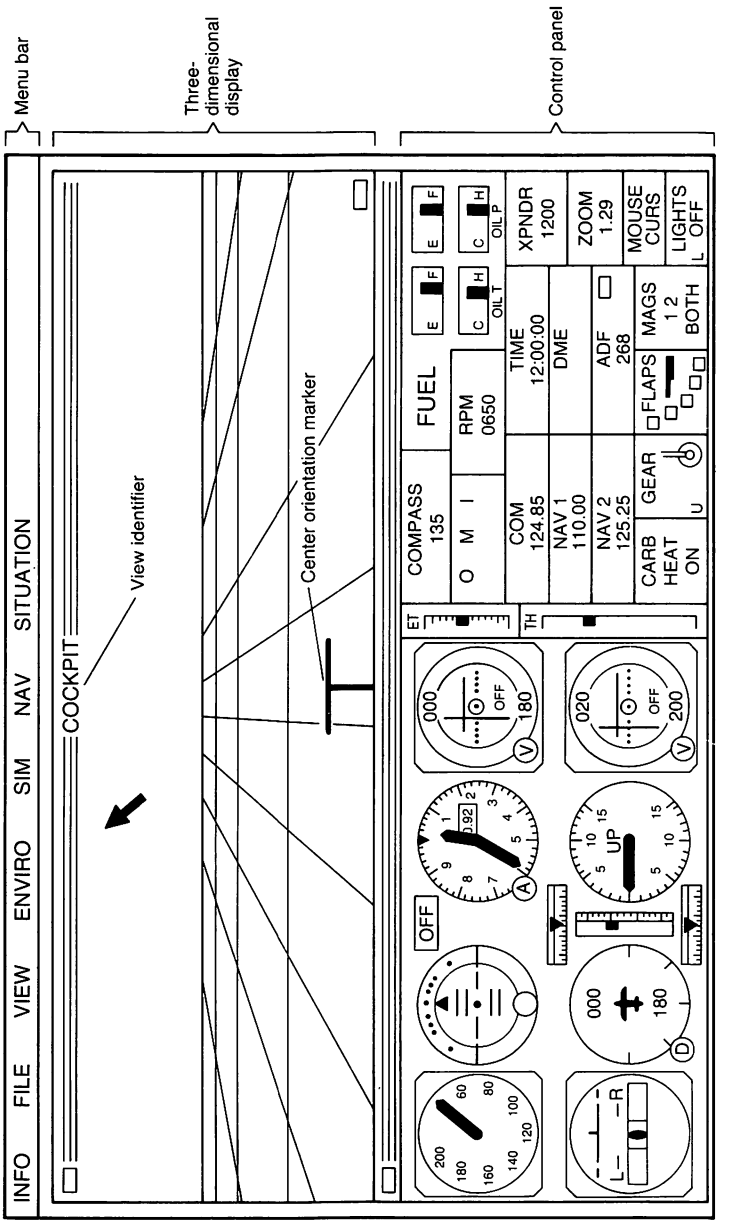


Figure 1. Flight Display on Color Monitor

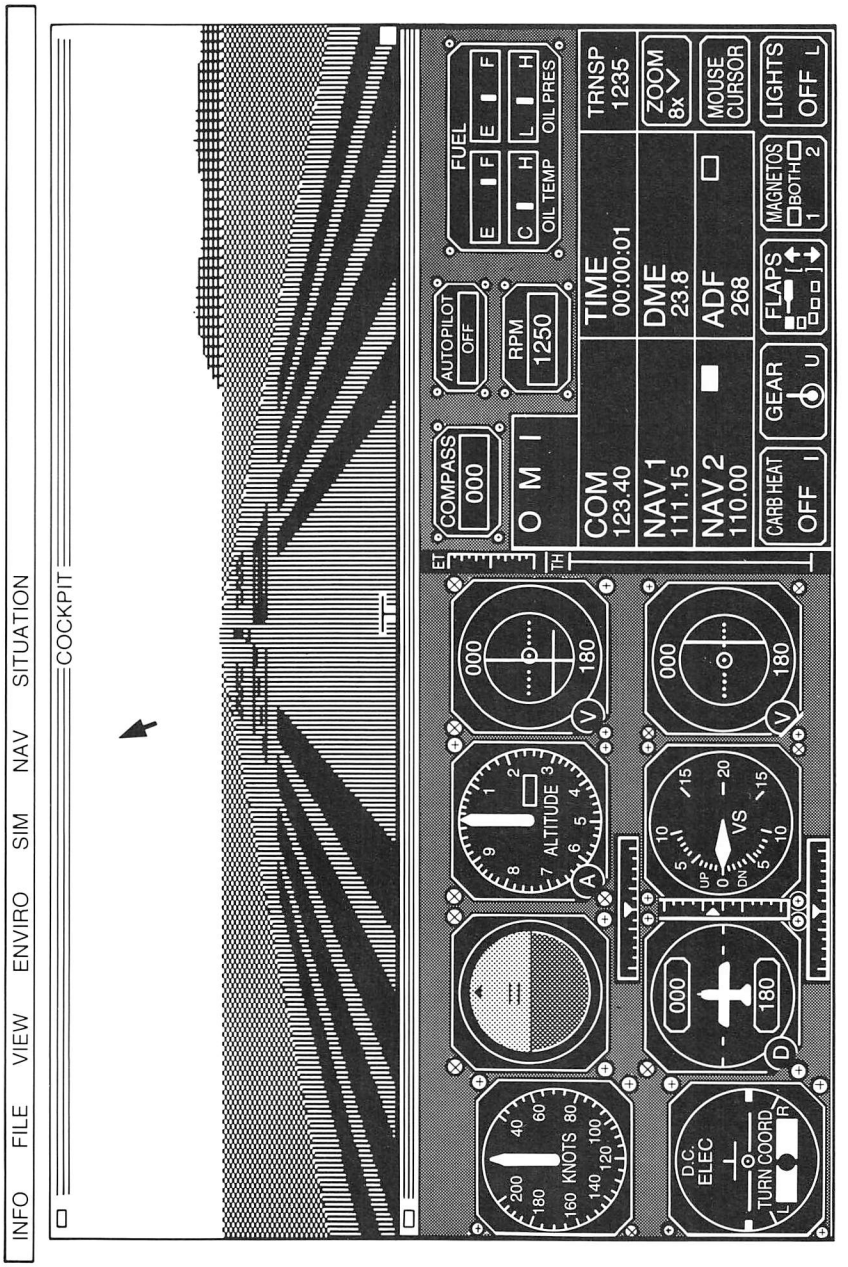


Figure 1a. Flight Display on Monochrome Monitor

box in the lower right corner) so you must rely on the center orientation marker (or wingtip markers when looking out side views) as the aircraft-to-scenery visual reference.

You can move the 3D window around on the screen by dragging the title bar at the top of the 3D window. Title bars on Flight Simulator II are not as tall as they are on most other programs, but they serve a similar function. By double clicking on a title bar, you can expand the window to its full size. You can use the SIZE box to change the window's size. You can move windows by dragging the title bar position at the top of the window even when window titles are turned off.

There are limitations on how big you can "grow" the 3D screen. You can't overwrite the instrument panel, for example. The program automatically limits expansion so you don't have to worry about what the limits are.

The smaller you make the 3D image, the faster it will update. You can also turn off the center orientation marker and title bars to increase update rate. The plane is more controllable when the screen is updating quickly, so on landing approach and other critical maneuvers, shrink the screen down to no more than half the full screen size. For sight-seeing and slow flight, slowly-updating full-screen images give better detail.

THE INSTRUMENT PANEL AND RADIO STACK

The instrument panel and radio stack window occupies the lower half of the screen. The panel can be moved downward by dragging it by the top of the window. This makes room for a larger 3D view and map display. Double clicking on the top of the window puts the panel back into its normal position.

Instruments on the panel and radios in the stack are arranged as they would be in nearly any aircraft. The style of these instruments varies from plane to plane. The most modern form of each is used in Flight Simulator II. Appropriate instruments (high-speed airspeed indicator and ADF readout) are switched in when Learjet or ADF modes are selected.

THE STANDARDIZED INSTRUMENT CLUSTER

The six basic flight instruments are grouped in the standardized instrument cluster shown in Reference Figure 1 in APPENDIX I of this manual. This cluster includes:

1. Airspeed Indicator (indicates airspeed in knots).
2. Attitude Indicator or Artificial Horizon.
3. Altimeter (altitude in feet above sea level, not above ground level).
4. Turn Coordinator.
5. Heading Indicator (directional gyro or gyro-compass).
6. Vertical Speed Indicator or Rate of Climb Indicator (reads in hundreds of feet per minute).

These instruments are arranged as they would be in nearly any aircraft. The style of these instruments varies from plane to plane. The most modern forms are used in this simulator.

Airspeed Indicator (item 1)
This instrument measures airspeed in knots. This is an air-pressure-activated gauge and indicates the speed the aircraft is moving through the air around it. This gauge does not show ground speed.

Attitude Indicator or Artificial Horizon (item 2)
The words "artificial horizon" summarize this instrument's function. Markings on the instrument's face aid you in determining the aircraft's pitch and bank attitudes. The center bar, when aligned with the horizon, indicates straight and level flight. Bank markings at the edge of the instrument indicate 10-, 20-, 30-, and 60-degree banks. The bank indicator (a small arrow at the top of the gauge) points to the bank markings. The arrow is stationary at the top of the gauge - the markings around the edge move. Horizontal markings near the center indicate nose-up and nose-down pitch angles of 10 and 20 degrees.

Altimeter (item 3)
Altitude in feet above sea level is measured. This gauge is read as a clock face with 10 instead of 12 divisions. The small hand indicates thousands of feet,

while the large hand indicates hundreds. The FS2 altimeter has fine 20-foot increments between the 100-foot markings. Atmospheric pressure operates this gauge. Barometric pressure changes caused by changes in the weather can cause errors in the altitude reading, so pilots flying below 18,000 feet must often calibrate this gauge to the barometric pressure of the airspace through which they are flying. The small knob on the gauge is used to set the barometric pressure in the small square window on the face of the altimeter. The FS2's altimeter can be adjusted for barometric pressure by clicking on the knob.

A small arrow near the outside of the gauge acts as the gauge's "third hand" which indicates tens of thousands of feet. Remember, this gauge reads altitude above sea level, not ground level. At an airport at a 750 ft. elevation, the altimeter reads 750 ft. while sitting on the ground (after barometric pressure adjustment).

Turn Coordinator (item 4)
The airplane front silhouette indicates rate of turn. No numerical value is presented on this gauge. Instead, a single turn rate position is marked. When the gauge aligns with the L or R, a 2-minute turn results (a turn rate of 180 degrees per minute). The turn coordinator, unlike the turn indicator gauge used in some planes, uses a 35-degree canted gyroscope that reflects both bank and heading changes. Pitch, however, has no effect on this gauge.

The ball portion of the turn indicator is a slip/skid indicator that indicates the degree of aircraft coordination. When the ball is centered, the aircraft's longitudinal axis is parallel to the direction of flight and the flight is coordinated. Coordinated turns are the safest turns and require appropriate amounts of bank and yaw using ailerons and rudder. Some maneuvers (notably slips and skids) are not coordinated. These will be covered in the ADVANCED FLIGHT TECHNIQUES section of this manual.

Heading Indicator or Directional Gyro (item 5)
This is basically a gyroscopically-controlled compass. This compass is much more responsive and steady than the magnetic compass (item 7) which tends to bob around unless the aircraft is flying smooth, straight, and is not accelerating or decelerating. The FS2's heading indicator shows both course (top readout) and reciprocal course (bottom readout). The heading indicator, being gyroscopically operated, has no inherent direction seeking characteristics and must be set manually using the magnetic compass before a flight. Gyroscopic procession and the earth's rotation cause the gyro-compass to drift over a short

period of time, so the pilot should occasionally (at least a couple times per hour) adjust the gyro-compass to match the magnetic compass.

The FS2's heading indicator can be set to the current magnetic compass heading by clicking the heading indicator's knob. Make sure the magnetic compass has settled down after a turn or airspeed change to avoid an erroneous heading setting.

Vertical Speed Indicator (item 6)
This instrument shows rate of climb or descent in hundreds of feet per minute. This gauge operates on air-pressure change and is not adversely affected by absolute barometric pressure. New pilots are cautioned not to "chase" this gauge in pursuit of constant-altitude flight. The gauge lags slightly behind the aircraft's responses and so will the pilot's responses if this gauge is chased.

OTHER INSTRUMENTS

Magnetic Compass (item 7)
This instrument appears at the top of the panel above the radios. This is a standard magnetic compass. It is assumed to be magnetically correct and requires no correction card to interpret. The compass is subject to isogonic effects (variations in true versus magnetic north).

Omni-Bearing Indicator with Glide Slope (items 8 and 9)
Item 8 is a navigation and landing approach instrument that is used in conjunction with the NAV radio and VOR stations. This instrument and its operation will be explained in the NAVIGATIONAL AIDS section. A second omni-bearing indicator (item 9) with no glide slope is provided. Two NAV radios and omni-bearing indicators are useful in navigation and greatly simplify instrument flight.

Clock (item 10)
This is a standard digital clock that measures hours, minutes and seconds. This clock runs in real time. Under the 1982 Federal Aviation Regulations, a digital presentation qualifies for IFR flight in lieu of an analog sweep second hand clock.

O, M, and I Lights (item 11)
These indicators are the Outer, Middle, and Inner marker lights that are used on instrument approaches.

ENGINE MONITORING INSTRUMENTS

Left fuel tank gauge (item 12)

Right fuel tank gauge (item 13)

Oil temperature gauge (item 14)
C and H stand for Cold and Hot oil temperature.

Oil pressure gauge (item 15)
L and H stand for Low and High oil pressure.

Digital tachometer (item 16)
Indicates engine RPM.

RADIOS

Six radios are provided: the NAV1 and NAV2 (navigation), COM (communication), DME (distance measuring equipment), ADF (automatic direction finder), and transponder.

Navigation radios (items 17 and 18)
These are used to tune-in and identify VOR navigation aids (to be covered later). These are 200-channel radios that receive frequencies between 108.00 and 117.95 MHz with 50 kHz separation. These receivers control the omni-bearing-indicators (Reference Figure 1, items 8 and 9). The NAV1 radio controls the top omni-bearing indicator, and the NAV2 radio controls the bottom omni-bearing indicator.

DME radio (item 19)
This is tuned to the NAV1's VOR station. Its digits tell you how many nautical miles from the VOR station you are.

ADF Automatic Direction Finder (item 20)
Used to tune non-directional radio beacons (NDBs). When the ADF option is selected, the bearing indicator (the gauge used with the ADF receiver) takes the place of VOR2, and the ADF receiver replaces the NAV2 radio. The ADF receiver covers the frequencies from 200kHz to 1699kHz in 1kHz increments.

Communication radio (item 21)
This is a 360-channel transceiver that covers frequencies between 118.00 and 135.95 MHz with 50 kHz separation. The flight simulator uses the COM radio as a receiver only. Airport, weather, and approach information can be received by tuning in Automatic Terminal Information Service (ATIS) which is available near major airports. The area maps give the ATIS frequencies for each airport where ATIS is available. The common traffic advisory frequency is listed for airports with no ATIS.

Transponder (item 22)
This radio is used to identify your aircraft on Air Traffic Control radar.

Encoding Altimeter and ELT (not on panel)
Two additional radios are added for the sake of completeness. An encoding altimeter is hidden behind the instrument panel (so ATC can check your altitude), and an emergency locator transmitter is mounted behind the back seats (so you can be rescued when you crash).

CONTROL POSITION INDICATORS

Aileron Position Indicator (item 23)
Indicates the ailerons position. When the arrow on the indicator is aligned with the center mark, the ailerons are centered. When the arrow points to the right of the center mark, right aileron is applied. When the arrow points to the left, left aileron is applied.

Elevator Position Indicator (item 24)
Indicates elevator position. When the indicator is aligned with the center mark, the elevator is centered. When it is above the center mark, the elevator is raised.

Rudder Position Indicator (item 25)
This indicator works just like the aileron indicator. In auto-coordinated flight mode, the aileron and rudder position indicators work together.

Throttle Position Indicator (item 26)
Indicates how much throttle is applied. The indicator goes up on the screen as more throttle is applied

Elevator Trim Indicator (item 27)
This shows the elevator trim setting. The sense of direction corresponds to the elevator indicator.

INDICATOR ICON BOXES

Carb Heat Indicator (item 28)
Indicates whether carburetor heat is turned on or off.

Landing gear indicator (item 29)
Indicates whether the landing gear is lowered or raised.

Flap position indicator (item 30)
Shows the position of the flaps.

Magnetos Indicator (item 31)
This indicator shows the condition of the magneto switch (OFF, LFT, RGT, BOTH, START, LEAN).

Lights Indicator (item 32)
This indicator tells whether the aircraft's lights are on or off.

Mouse/Yoke indicator (item 33)
Indicates whether the mouse is controlling the cursor or the control yoke. The word "CURS" or "YOKE" will tell which is currently under control.

Zoom indicator (item 34)
Indicates the visual display zoom factor.

Autopilot Status Indicator (item 35)
Indicates whether the autopilot is on or off.

AIRCRAFT CONTROLS

Flight Simulator II, like a real aircraft, has many controls: engine function controls, flight controls, and navigation and communication radios. All the controls are necessary for safe, efficient flight, but only the primary flight controls are needed to get you flying.

The first steps in getting Flight Simulator II off the ground are to learn about the mouse and keyboard interactions involved in flying the simulator, then get proficient at using the primary flight controls. The view controls and secondary controls can be learned later.

MOUSE AND KEYBOARD INTERACTION

In Flight Simulator II, the mouse operates in two modes: YOKE and CURSOR.

Mouse Yoke Mode: In yoke mode, the mouse acts as the aircraft's control yoke or stick. Figure 2 shows mouse functions in yoke mode. Movements forward and backward control aircraft pitch (nose up and down), and left and right movements control bank, which causes you to turn left or right. In yoke mode the mouse acts as if it's the tip of a large joystick. The elevator and rudder position indicators on the control panel move as the mouse is moved.

Throttle and brakes are also mouse-controlled in yoke mode. Holding the left button down and dragging the mouse forward and backward increases and decreases throttle. Dragging the mouse to the left applies brakes, and dragging to the right releases them. The throttle indicator on the panel shows throttle movement (engine RPM also changes as you move the throttle), and a brakes indicator near the center orientation marker indicates that brakes are applied. Brakes are only effective on the ground and are automatically released when you are in the air (to avoid landing with brakes on).

Double-clicking the left button (or pressing the right button) toggles between cursor and yoke mode.

The mouse control sensitivity is adjustable by selecting CONTROL SENSITIVITY under the SIM menu. See the SIMULATION CONTROL section of this manual for details.

Mouse Cursor Mode: The mouse is used to select menu items similar to the usual Operating System way when in cursor mode. A pointer moves about the screen and you can click from menu bars using the left button. Pointing at the 3D screen or mouse icon on the control panel and double clicking (or pressing the right button) puts you back into yoke mode.

Keypresses: Keyboard key functions are summarized in Reference Figure 2 in APPENDIX I of this manual. All keypress functions except rudder pedals are also available from mouse-selectable menus. For example, you can use the [C] key to select control tower view, or you can select VIEW from the menu bar and then pick your view from the menu.

Both mouse and keyboard should be used when flying Flight Simulator II. Although there are mouse commands for nearly all functions, the large number of controls makes it hard to get at some of them quickly. To change view using the mouse would require you to double click into cursor mode, select the menu bar, drag to the VIEW menu item, point at the 3D screen and double click back into yoke mode. It's quicker and less disrupting to press the [C] key, especially on a final approach when yoke control is so important.

If you find that you don't remember a certain key code, it is convenient to select the function from the menu. The key code is always shown in quotes next to the function. This will remind you of the key to use next time.

PRIMARY FLIGHT CONTROLS

The primary flight controls include the control yoke (a steering-wheel-like control on most planes, a control stick on others), the rudder pedals, the throttle, and brakes. The mouse, when placed into yoke mode (by pressing the left button or double clicking on the 3D screen or mouse icon on the control panel), performs elevator, aileron, throttle and brake controls.

Familiarize yourself with the definitions of yaw, pitch, and roll (see Figure 3). Fig. 3 also shows the aircraft control surfaces (movable wing sections that cause the aircraft to yaw, pitch and roll about its axes). Mouse movements correspond to the physical positioning of the yoke and rudder pedals in an aircraft.

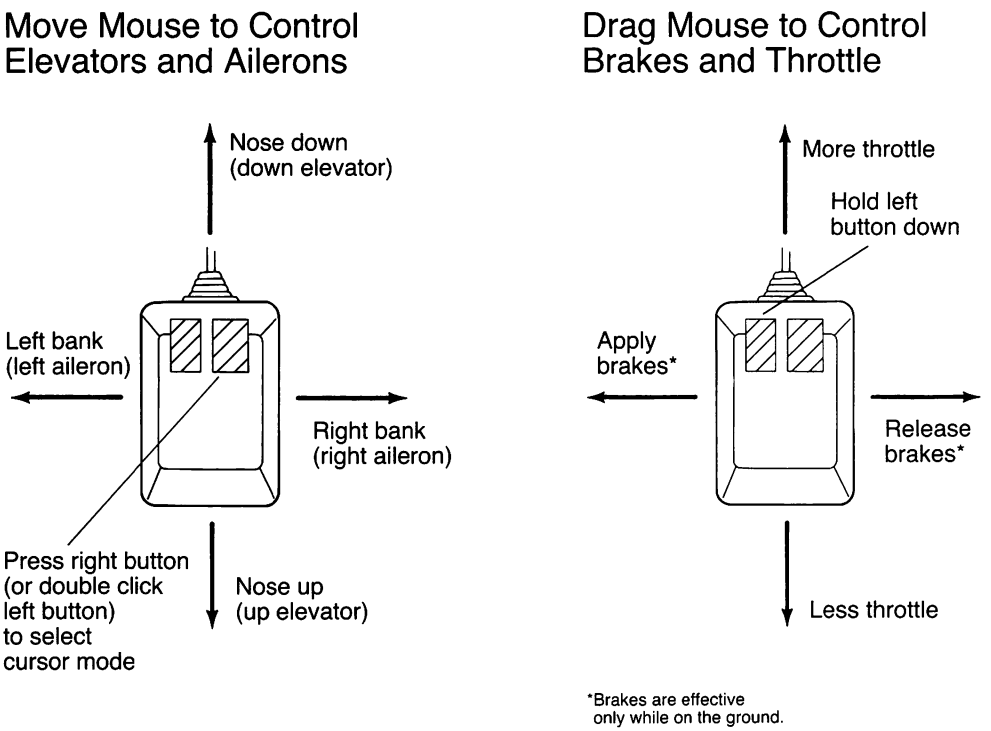


Figure 2. Mouse Functions in Yoke Mode

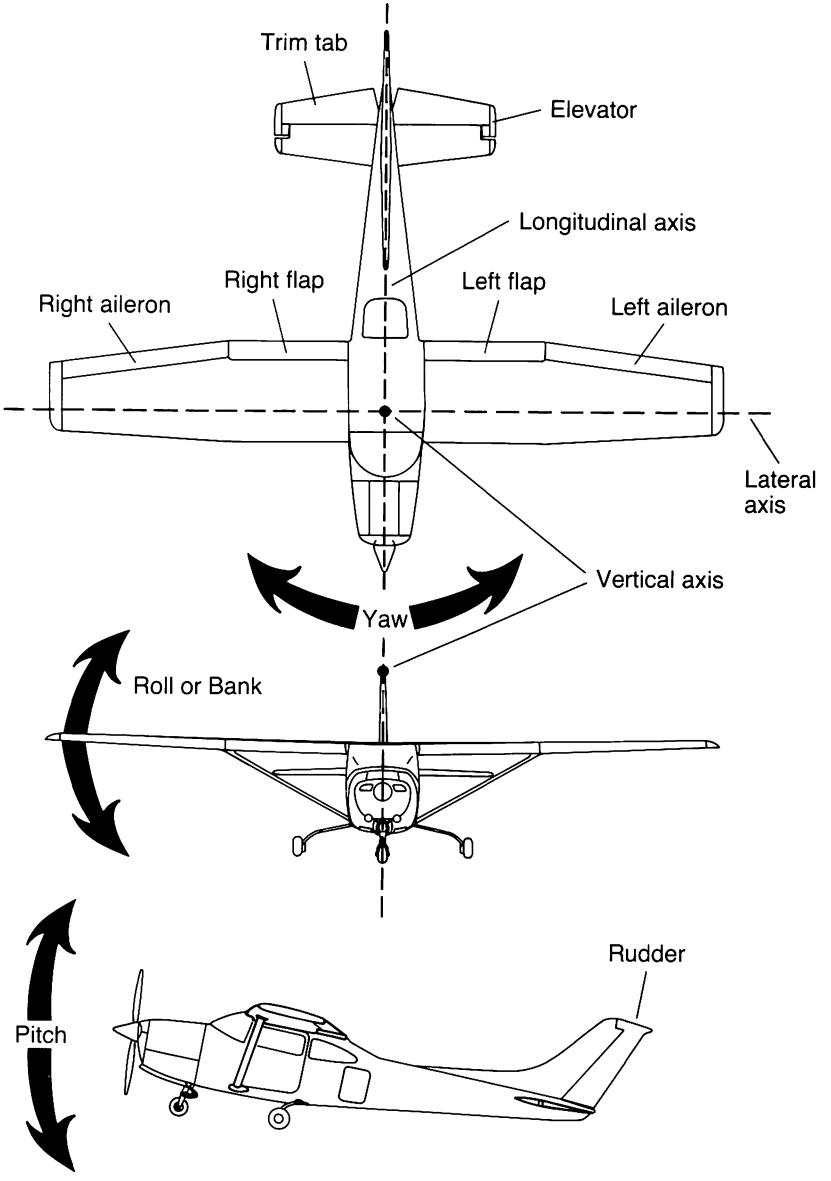


Figure 3. Primary Flight Controls

Control position indicators are shown on the instrument panel (Reference Figure 1, items 23, 24, 25) and follow the yoke movement.

Control Yoke (or Stick)
Yoke rotation or stick right-left movement controls the ailerons and causes the aircraft to roll. Yoke movements toward and away from the pilot or stick forward and back movement controls the elevator and causes the plane to pitch nose-up or nose-down.

Figure 4 shows the yoke's aileron control function and effects.

Figure 5 shows the yoke's elevator control function and effects.

Practice using the yoke:

1. Boot up FS2 if it's not already running.
2. If a pointer is visible on the screen, press the mouse's right button to go into yoke mode.
3. Move the mouse to the left and right (aileron bank left and right).
4. Notice the control indicator move to the left and right.

NOTE: The aileron and elevator only have an effect while flying. They cause no aircraft response while the aircraft is stationary on the ground.

Rudder
The keypad keys [0] and [.] control the rudder. In auto-coordinated flight mode (the mode the simulator comes up in), the rudder and ailerons are linked. Adjusting one also adjusts the other. This allows you to fly without using the rudder under mouse-only control. Figure 6 shows rudder control functions.

Throttle
The throttle applies power. Dragging the mouse forward and backward with the left button held down while in yoke mode controls throttle. Dragging forward increases power, and dragging backward decreases it.

The throttle position indicator shows the throttle setting. Figure 7 shows throttle control functions.

Brakes
Apply brakes to slow the aircraft while on the ground by dragging the mouse to the left with the left button pressed down. Release brakes by dragging to the

right. A "BRAKES" indicator will appear on the 3D screen near the center orientation marker when brakes are applied. These are wheel brakes only and have no effect in the air. Brakes are automatically released while in the air to avoid landing with the brakes on. Figure 7 shows brake control functions.

KEYBOARD PRIMARY FLIGHT CONTROLS

The keypad can be used for primary flight controls instead of the mouse. Figures 4 through 7 show the appropriate keys for yoke, rudder, throttle and brake functions.

When flying using keyboard control, remember the keypad keys by position rather than by number. The control keys are arranged in a "control diamond" pattern that corresponds to stick or yoke movement (left key for left roll, right key for right roll, etc.).

Keyboard Yoke and Rudder

The aileron, elevators, and rudder keys all adjust control surfaces a small amount for each keypress. Watch the control position indicators on the instrument panel to know the control position. Holding keys down for a long time will result in multiple keypresses.

The [5] key centers the aileron and rudder only. The elevators are not centered by this key.

Micro-adjustable Elevator

The elevator often requires large control movements, but at other times requires very small movements. Making the elevator sensitive enough to perform small movements would have required more than 50 notches of elevator to handle the large control movements. Instead, a "micro-adjustable" elevator is used.

Rapid elevator keypresses cause the elevator to move in large steps (about 30 notches from full up to full down). Single keypresses or sequences of keypresses at intervals greater than half a second result in 1/8 scale "micro-movements" (240 notches from full up to full down). The indicator has only 30 positions, so micro-movements only show on the indicator once every eight keypresses.

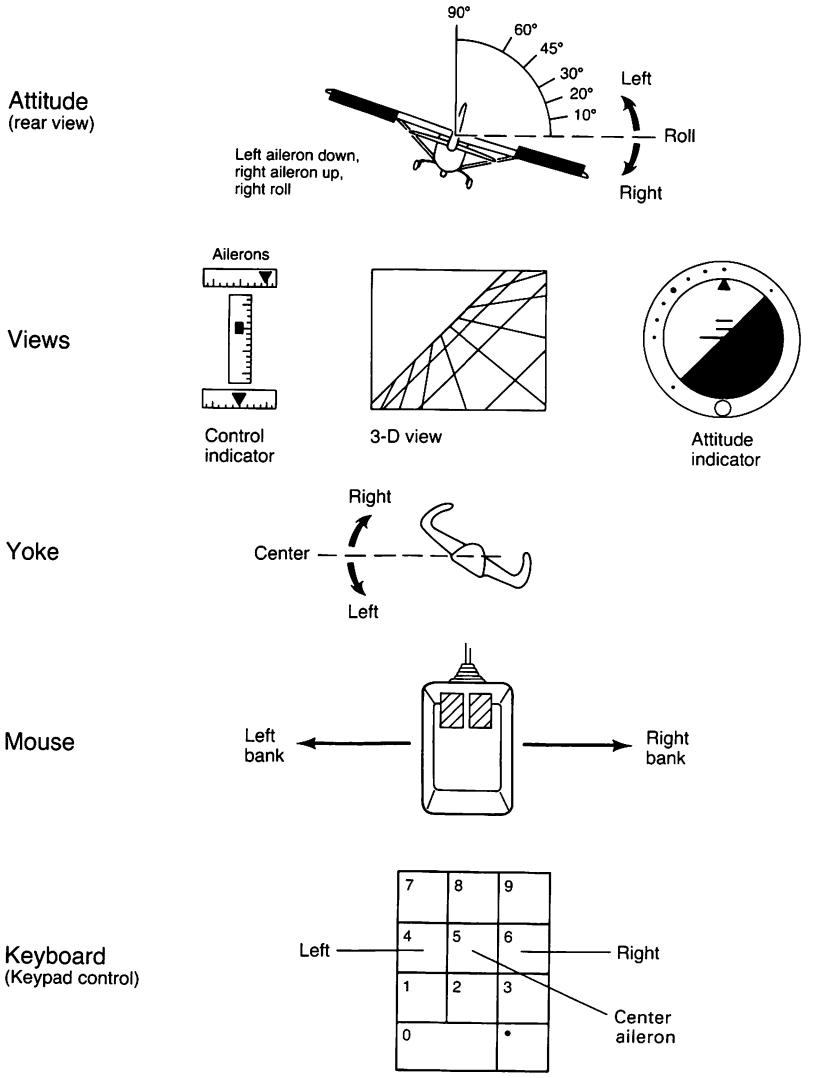


Figure 4. Aileron Controls and Effects

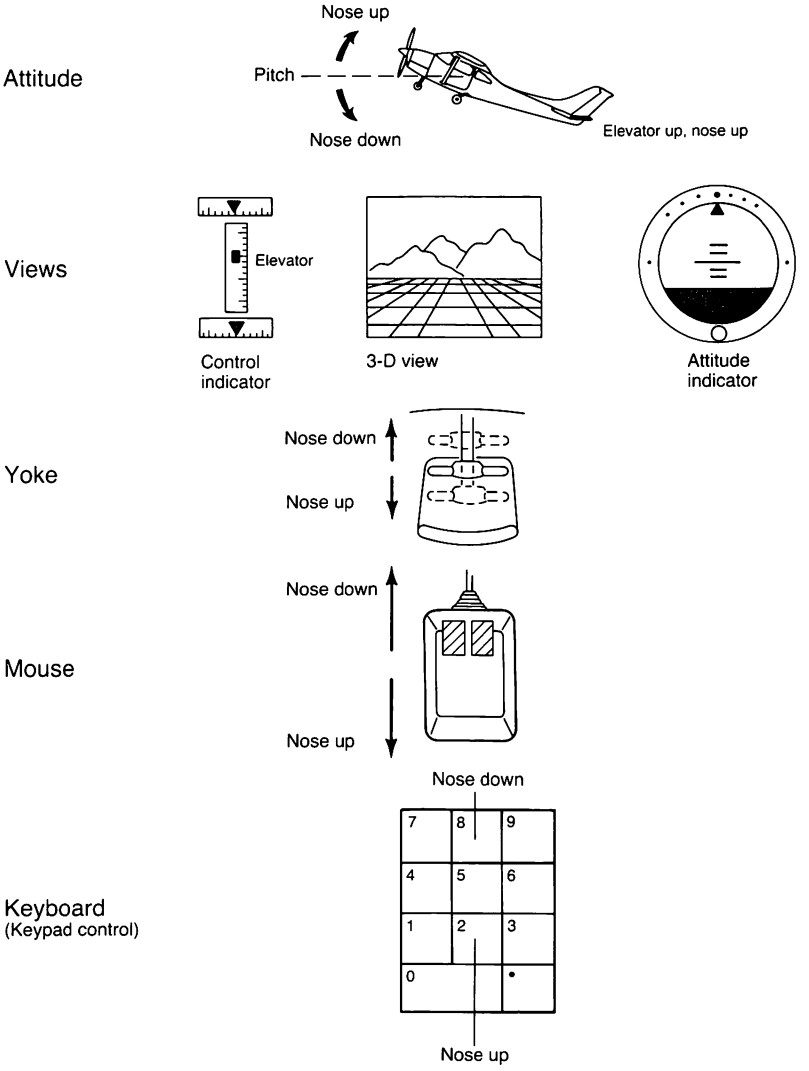


Figure 5. Elevator Controls and Effects

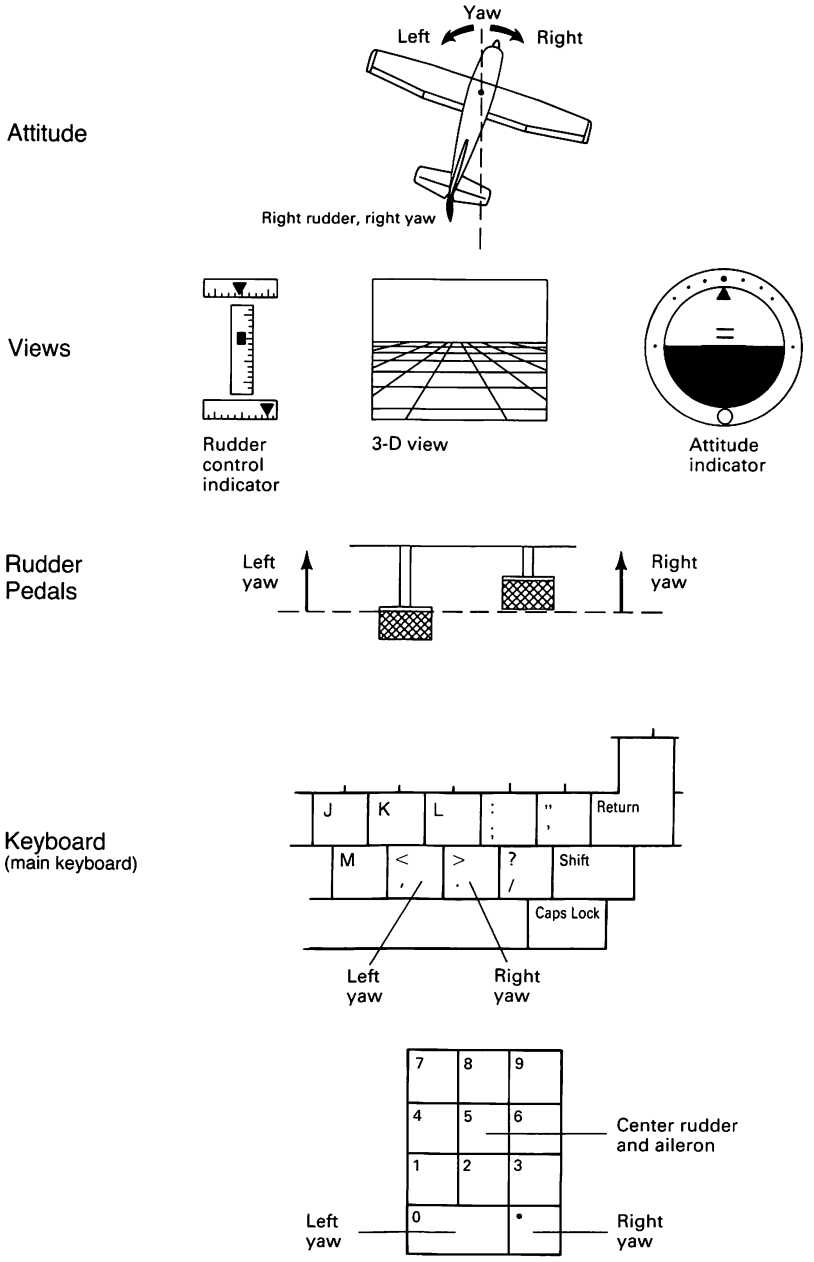


Figure 6. Rudder Controls and Effects

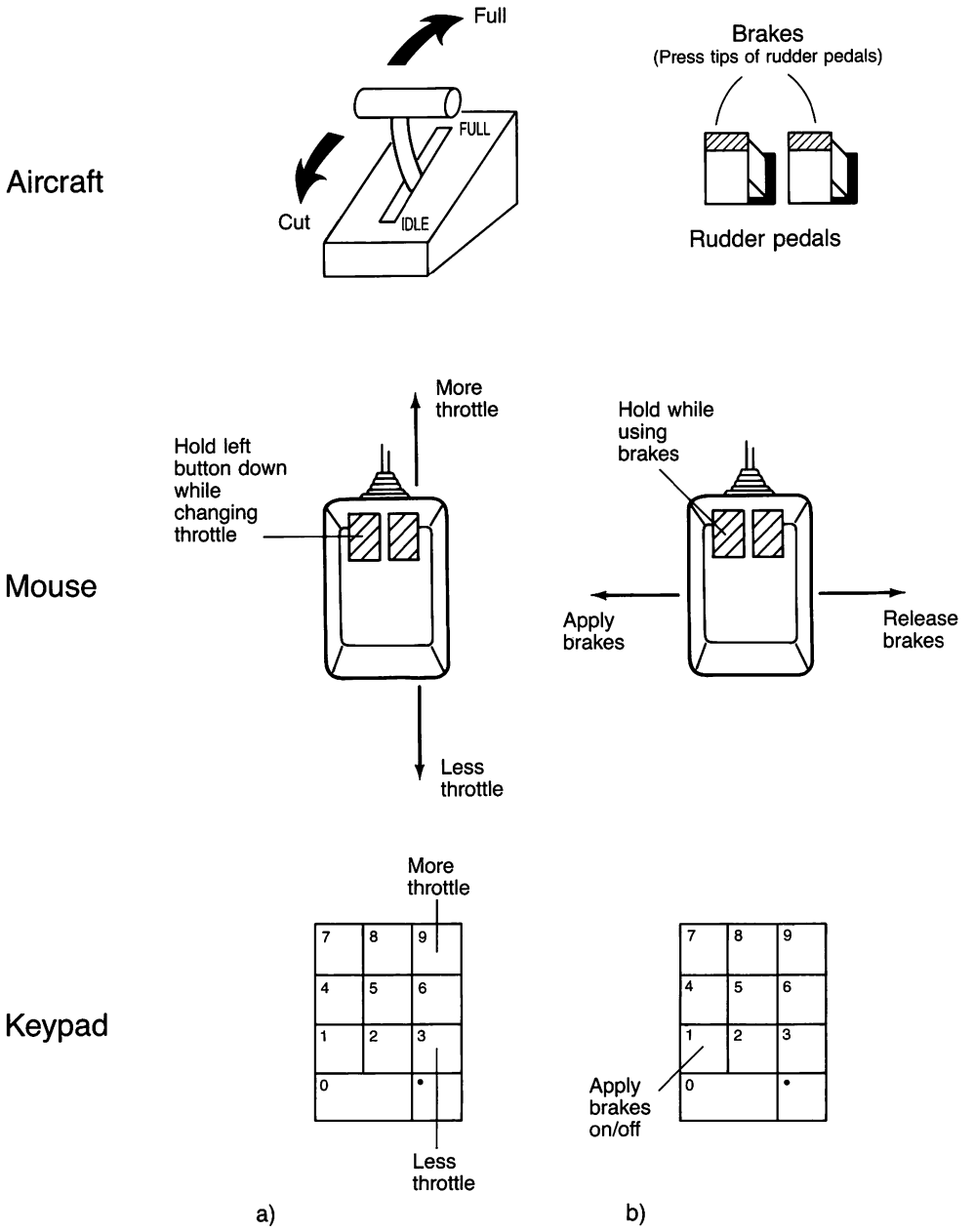


Figure 7. Throttle and Brake Controls

Micro adjustments are good for making small adjustments (when establishing straight and level flight for example), and large movements are useful when large changes are required.

Keyboard Rudder, Brakes and Throttle

These controls are also grouped on the keypad for complete primary control. Figures 6 and 7 show these controls. Each brake keypress reduces your speed by a few knots while on the ground.

VIEW CONTROLS

Flight Simulator II has a sophisticated viewing system that gives you a wide range of views from the aircraft as well as views of your aircraft as you fly. There are four visual view modes: cockpit, tower, track, and spot. The view mode determines your viewing point. There are also view direction controls, zoom, and an optional second three-dimensional window. A separate map display is available.

VIEW MODE SELECTION

The [S],[D],[X],[C] keyboard key group (see Figure 8d) selects view mode. The VIEW menu can also be used to select view mode (see Figure 8a):

COCKPIT: In this mode you are looking out of the aircraft's windshield.

TOWER: You are looking out from a stationary control tower. This mode automatically tracks your movements, keeping you in view.

TRACK: In control tower mode it is easy to fly out of range of the control tower and disappear into the distance. When track mode is selected, the tower "chases" you if you get too far away. It tracks your motion. The tower always stays on the ground, and it stops chasing you if you get within the tracking distance (such as when you turn toward it to do a fly-by). The tracking distance is menu-adjustable.

SPOT: This mode is the view from a spotting aircraft flying next to you (or behind, below, or in front of you). You get to choose where the spotter aircraft is placed and how far from you it will fly using the SET SPOT PLANE menu. You may also select whether the spot plane will constantly maintain its spot position (FAST UPDATE on the SET SPOT PLANE menu) or will chase you (SLOW UPDATE).

The title bar above the 3D display tells what view mode the 3D window is in. When looking straight ahead in cockpit mode, no title appears above the 3D window. This gives the best possible view and projection rate.

ZOOM CONTROL

In all modes you have a zoom control. You can zoom in or out (change your field of view) by pressing keyboard keys [+] or [-] for fine zoom control or [F9] or [F10] for coarse zoom control. You can also change zoom factor using the zoom menu (see Figure 8c). When landing, taking off, and doing aerobatics, make sure the zoom control is on 1X (press [Backspace]). View distortion in wide-angle and telephoto views can adversely affect your sense of direction and movement. The "ZOOM" digits on the lower right side of the control panel show the zoom factor.

COCKPIT VIEW DIRECTION CONTROL

In cockpit mode you can view from 9 different directions. Figure 8 shows view directions and how to select them using menu options and keyboard control. It is best to use keyboard control to select viewing direction. You will be using it a lot, and having to go in and out of cursor mode to select from menus reduces the ability to just casually "look around". Just remember that the view control keys are centered around the [G] key.

You can make fine adjustments to your view direction using the cursor keys located to the right of the main keyboard. The [cursor left] and [cursor right] keys pan left and right. The [cursor up] and [cursor down] keys pan downward and upward respectively. Changing view direction (by pressing [Y] for example) after making a fine view adjustment will cancel the horizontal adjustment, but will not affect the vertical adjustment.

The VIEW DIRECTION item on the VIEW menu activates a dialog box that is used to select view direction (see Figure 8b).

SET SPOT PLANE

Track and spot distances are adjusted by selecting the menu item SET SPOT PLANE. This option activates the dialog box shown in Figure 9. Set the SPOT DIRECTION (where you want the spotter aircraft to be with relation to your plane) by clicking one of the four view direction boxes.

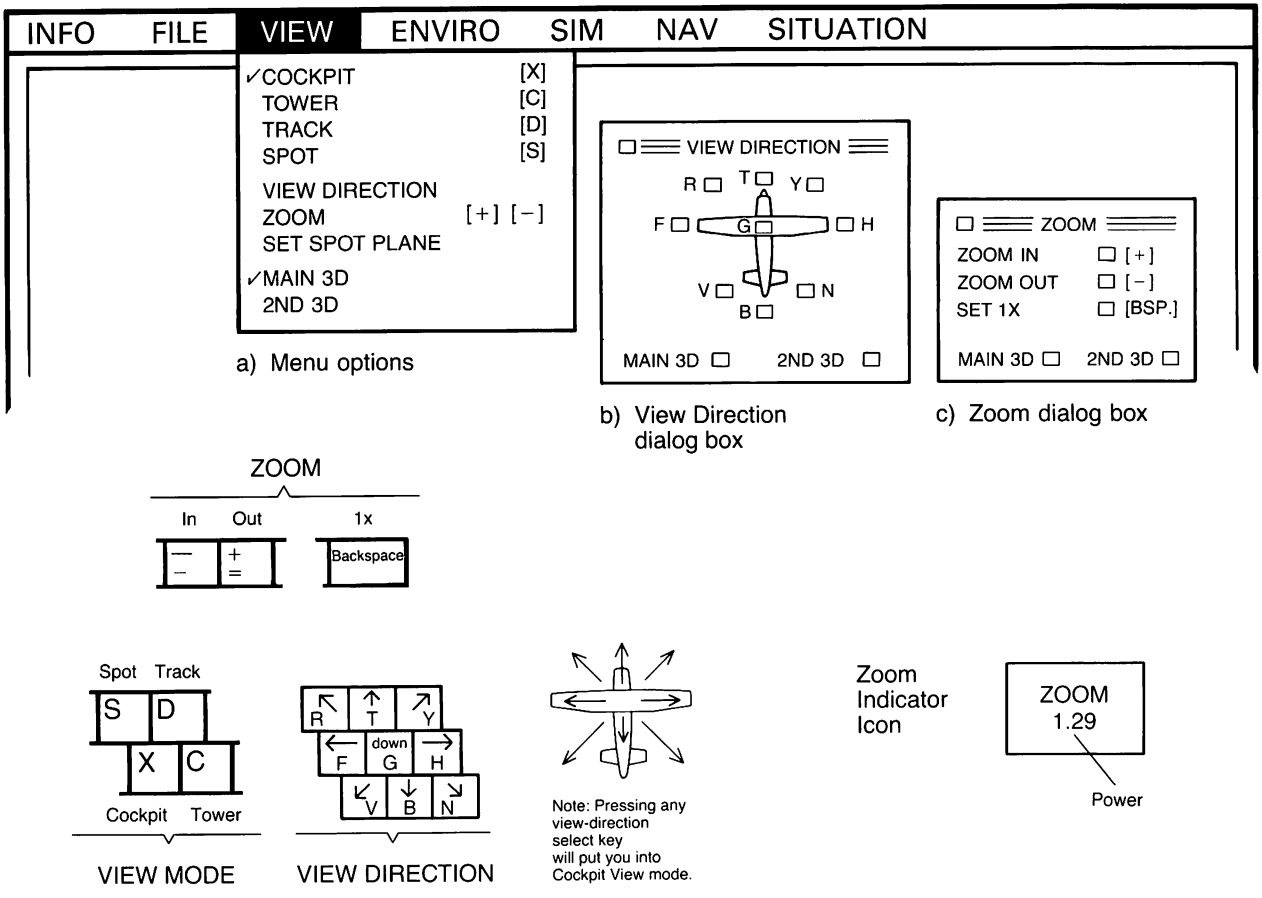


Figure 8. View Controls

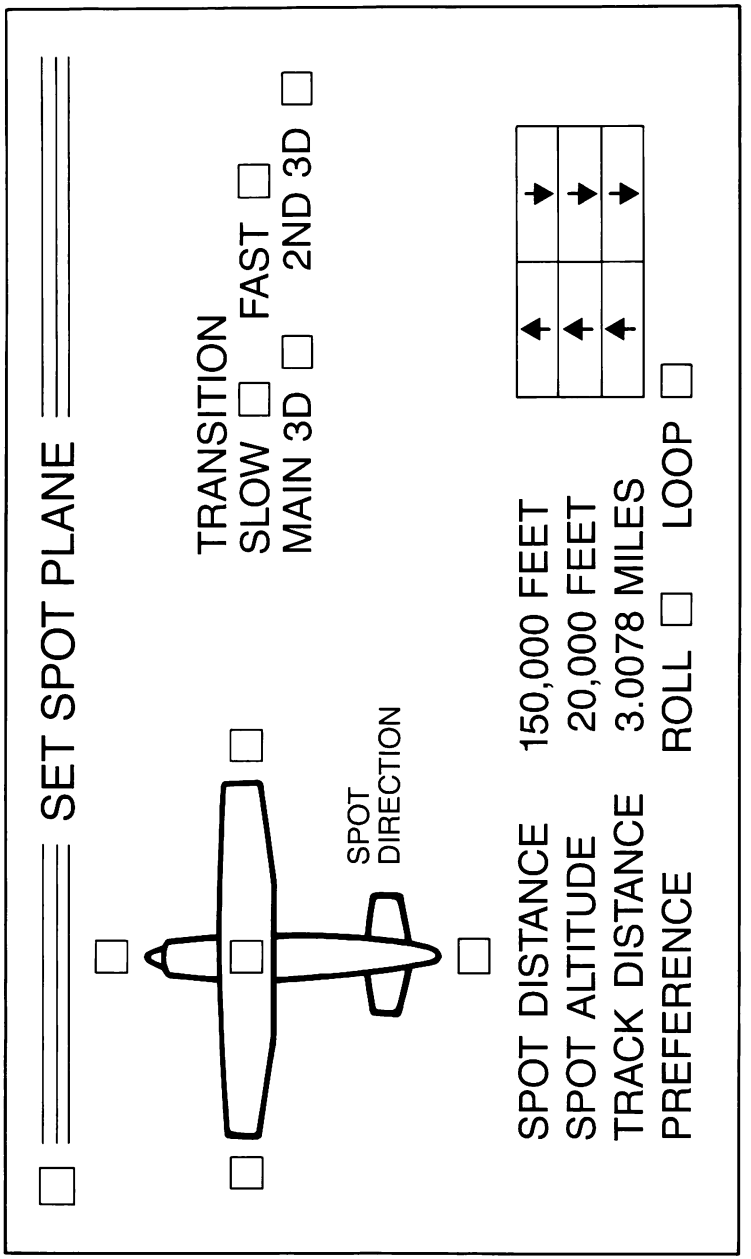


Figure 9. Set Spot Plane Menu

Spot distance is adjusted by clicking on the UP or DOWN adjustment arrows next to the SPOT DISTANCE readout. This will determine how far from you the spotter aircraft will fly. The selected distance appears next to the menu item.

SPOT ALTITUDE is the difference in altitude between the spotter pilot and yourself. Positive values place the spotter at a higher altitude than your plane. Negative values place the spotter below you. The spotter can never go below ground, and some dramatic landing views can be generated by placing the spotter slightly below and to the side of you.

The spot plane positions itself in the direction and at the distance shown on the SET SPOT PLANE menu (150 feet off your left wing and 20 feet above you, for example). The spot plane's position can change in undesirable ways when doing aerobatics. When you bank the plane steeply, and roll upside down, suddenly the wing that was pointing east points west. The spotter plane should then switch to the other side if it is to match the SET SPOT PLANE diagram. The spot plane jumping from side to side makes it hard to watch yourself do aerobatics. A similar undesirable transition happens when you do a loop (pitch upward then go all the way over).

There are two menu items that tell the spot plane how to act during these transitions. You can adjust them for the kinds of visual special effects you want. Preference is settable to LOOP or ROLL. In "roll preference" mode the spot plane flies relative to your heading, not your wingtip. When you roll, your heading remains the same, and the spot plane will track you from one side, letting you watch the complete roll. Loops will still cause a problem though, because as you go "over the top" your heading abruptly changes by 180 degrees. To watch yourself do loops, choose "loop preference". The spot plane will track based on your wingtip direction (which doesn't change during a loop).

In ROLL or LOOP preference modes, there are times when the spot plane has to switch which side of you it's on. Rather than changing sides abruptly, the spot plane gradually moves itself to the other side, keeping you in view all the while. Think of the spot plane as a fellow pilot filming you with a movie camera. The spot plane must fly its way to the other side. The crossover creates dramatic visual effects. You can set the cross-over time by setting TRANSITION on the spot plane menu to SLOW or FAST.

SECOND THREE DIMENSIONAL WINDOW

You can fly with two 3D window views at once. The second 3D window is activated by pressing the [F2] key or selecting the VIEW menu item SECOND 3D. The window will appear, and you can adjust its size using its SIZE box.

The second window has all the capabilities of the main window. After pressing [F2] all zoom and view control keypresses will affect the second 3D window. (In order to change zoom or view control in the first 3D window when more than one 3D window is active, press [F1].) If more than one 3D window is visible, the one that will be affected by keypresses is outlined in black. The others are outlined in white.

On VIEW DIRECTION and SET SPOT PLANE menus, click on control boxes at the bottom of the screen to indicate which window you are adjusting. The dialog boxes always come up with the primary 3D window selected.

Turn the second 3D window off by pressing the [F2] key twice in a row or by clicking on its CLOSE box.

You can achieve some interesting effects using two 3D windows, but the frame rate will slow down because two images must be projected. To improve speed, keep the second 3D window small, and turn it off when you don't need it.

THREE DIMENSIONAL WINDOW ON/OFF

The VIEW menu has options to turn the primary and secondary 3D windows on and off (MAIN 3D and SECOND 3D). A check mark next to the menu items indicate which windows are on and off. If you turn the primary 3D window off, you must click on the mouse icon to put the mouse into yoke mode because you can't double click on the nonexistent 3D window.

The [F1] and [F2] keys can also be used to turn the first and second 3D windows on and off. Press the appropriate key once to turn the window on, and twice rapidly to turn it off.

MAP DISPLAY

The map display allows you to look at a map of the area over which you are flying. You can also zoom in and out and see large or small areas. This is useful in navigation and taxiing around airports. Although this feature is part of the navigation system and is described thoroughly in the NAVIGATION section, it is appropriate to get to know how to use it at this time because it is used a lot when flying.

The map display is placed next to the 3D display. The window size is adjustable using the SIZE box, and the display can be dragged around the screen using its title bar.

To turn the map on, press the [F3] key. The [+] and [-] keys are used for fine zooming in and out. The [F9] and [F10] keys are used for coarse zooming. The [Backspace] key sets a zoom factor of 1X. After pressing [F3], all zoom keypresses will affect the map display until it is turned off or one of the 3D windows is selected by pressing [F1] or [F2]. When the map display is selected for zoom control, it will be outlined in black rather than white. You can also select MAP DISPLAY and MAP ZOOM from the NAV menu under mouse control. Further uses of the map display are presented in the NAVIGATION section of this manual.

Turn the map off by pressing the [F3] key twice in a row, or by clicking the MAP DISPLAY option on the NAV menu.

ASPECT RATIO

Aspect ratio refers to the relationship between the width and height of a window. The aspect ratio of what is shown in 3D windows can either be locked to a constant aspect ratio, or can be dependent upon the actual aspect ratio of the 3D window. If aspect ratio is locked, the aspect ratio of the field of view is locked to the aspect ratio of the 3D window, so as the window width is increased, more scenery will be visible. If aspect ratio is not locked, the field of view will remain a constant width and objects may look very distorted if the window is either very short or very wide. Keep the aspect ratio locked for normal flight. Unlock it if you want to see some interesting special effects.

ASPECT RATIO LOCK is selectable under the FILE menu.

SECONDARY AIRCRAFT CONTROLS

The secondary controls are associated with the control icons and radios at the right side of the instrument panel. They are used to navigate, control the engine, and control the simulator itself. Reference Figure 1 shows the position of many of these controls on the panel, and the rest are available through the menu bar. A description of how to use these follows. If this is your first flight, you may want to return to this section later.

Flaps

Flaps are movable panels on the inboard trailing edges of the wings. They are hinged so they can be extended downward into the flow of air beneath the wings to increase lift (upward force) and drag (rearward pull). Their primary purpose is to permit a slower airspeed and steeper angle of descent during a landing approach. They can also be used to shorten takeoff distance or decrease stall speed on landing approach.

The flap position indicator is shown in Figure 10a. Flaps can be lowered to the 10-, 20-, 30-, and 40-degree positions by clicking on the control boxes next to the flap indicator, or by pressing the [key to raise and the] key to lower the flaps. The keys to press are shown next to the arrow that shows flap movement direction on the "FLAPS" icon.

Elevator Trim

The control yoke is directly connected to the airfoils it controls. Different flight attitudes put different pressures on the airfoils. These variations also change the pressure on the yoke. The pilot must counteract these forces to keep the airfoils in their proper positions. Applying steady pressure on the yoke for hours would be fatiguing. Trim is used to counteract these forces and relieve the pilot from applying constant pressure on the yoke.

Flight Simulator II provides elevator trim controls. The [(] and [)] keys (on the keyboard, not the keypad area) let you adjust nose-up and nose-down trim. The trim only has an effect when ELEVATOR TRIM is selected in advanced flight modes. When this option is in effect, the elevators will tend to drift toward a certain position that is a function of aerodynamic effects and the elevator trim setting. Constant control movements (which correspond to constant pressure in a real aircraft) are needed to keep the pitch from drifting. When elevator trim is not selected while in easy flight modes, you can ignore the elevator trim setting. The elevator trim indicator is shown in Figure 10b.

Carburetor Heat

The [I] key (I is for Ice) is the carburetor heat toggle switch. The "CARB HEAT" indicator on the instrument panel shows whether carburetor heat is on or off (see Figure 10c). You can also click on the carburetor heat control box area using the mouse.

Carburetor heat is used to prevent icing or to clear ice that has already formed in the carburetor. Apply carburetor heat for a few seconds on landing approach to avoid ice-caused engine failure.

Magneto Switch and Mixture Full Lean Control

The "MAGS" icon control boxes and keyboard keys [1] and [2] act as the magneto switch. The magneto switch is similar to an ignition switch on a car. You can turn it to the right and left through a series of positions:

Position	Function
OFF	magnetos off
LFT	left magneto on
RGT	right magneto on
BOTH	both magnetos on
START	start engine
LEAN	mixture full lean (engine off)

The magneto is the aircraft's ignition system. Airplanes have two independent ignition systems for safety (a LEFT and RIGHT system). The mixture lean control is not part of the magneto switch on a real aircraft, but was integrated with this control because you turn an aircraft engine off by setting the carburetor mixture to full lean rather than by turning the ignition switch off.

The magneto controls only have an effect when the ENGINE option is selected in advanced flight modes. In easy flight modes, you can ignore the magnetos. The magneto indicator is shown in Figure 10d.

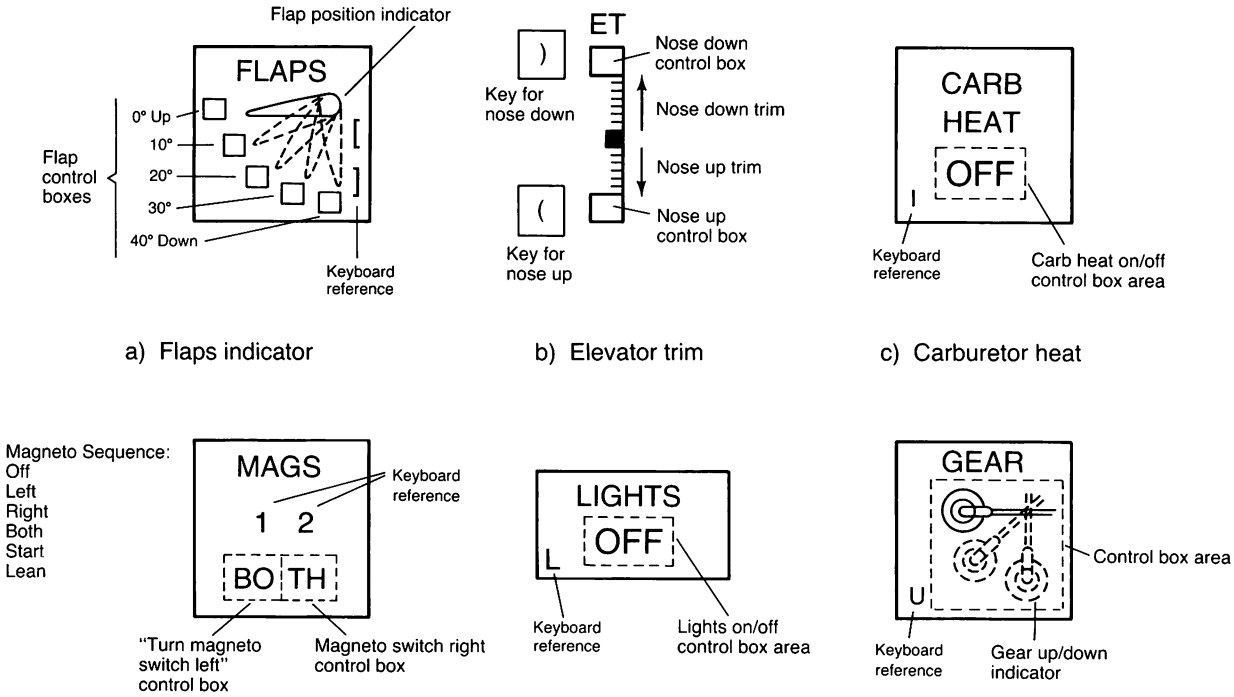


Figure 10. Secondary Control Indicators

Lights

The [L] key, or the control box area (see Figure 10e) under the "LIGHTS" icon, is used to turn on the running and instrument lights. Running lights are lights on the tips of each wing - red on the pilot's left, green on the right - that help others identify your heading. Instrument panel lights illuminate individual instruments on the instrument panel, so you can see them at night. You must turn on the running and instrument panel lights for night flight. It's not advisable to fly with your lights on during the day. If you do, when night arrives you may find that a bulb on an important instrument has burned out. Bulbs are replaced during refueling and service stops.

Landing Gear

The landing gear key [U] and the control box area under the "GEAR" icon (shown in Figure 10f) raise and lower the landing gear. The "GEAR" indicator on the panel shows the current status of the landing gear. You do not have to raise the landing gear when flying. If you do raise it, however, be sure to lower it on landing approach. Flying with the landing gear down increases drag and slows you down.

VOR Navigation Radios (NAV 1 and NAV 2)

The NAV radio is an important navigational aid. It is used to tune in VOR radio beacons so you can fly toward or away from them. Two NAV radios are provided so you can tune in two VOR beacons at once. This is useful for doing cross-checks of your position

You must set the NAV radio to the VOR frequency to receive the appropriate signal. On a real aircraft, two knobs are used to set the frequency. One sets the full megahertz frequencies (121, 122, 123, etc.), and the other sets the fractional frequencies in 50 kHz increments (.00, .05, .10, etc.). Many new radios are 720-channel models with 25 kHz separations, but none of these intermediate frequencies are implemented on Flight Simulator II.

To set the NAV radio frequency, point to the number you want to change on the radio on the instrument panel. Clicking the left mouse button changes the frequency. Pointing to the right digit of the number raises the frequency and pointing to the left digit lowers it. For example, to change from 124 to 127, point to the digit 4 and click 3 times. To change 124 to 122, point to the digit 1 and click twice.

Like real aircraft radios, the numbers to the left of the decimal point (full MHz increments) and to the right (50 kHz increments) are adjustable separately.

The NAV1 radio is also used to tune in ILS localizer and glideslope. For more information on instrument flying, see ADVANCED FLIGHT TECHNIQUES.

Omni-Bearing Indicator (OBI)

The OBI is used with the NAV radio to tune into VOR radio stations. VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver decodes these signals to determine what angle or "radial" from the station you are on. Radials can be thought of as directional beams radiating outward from the VOR station like spokes of a wheel.

The OBI or VOR Indicator is a panel-mounted instrument that lets you determine what VOR radial your plane is on. It also helps you fly along radials toward or away from the VOR station. Two OBIs are provided. The top OBI (Reference Figure 1, item 8) corresponds to the NAV1 radio. The bottom OBI (item 9) corresponds to NAV2.

To set the OBI, point to the digits on the OBI indicator and click the left side to decrease or right side to increase the setting.

Pointing and clicking the left and right sides of the adjustment knob will also adjust the setting.

ADF Navigation Radio

The ADF (Automatic Direction Finder) is a system that lets you home in on non-directional radio beacons. A three-digit frequency code can be set on the ADF receiver. Pointing at the individual digits and clicking the mouse sets the frequency.

ADF/VOR Selector

There was not enough room on the instrument panel to place two Omni Bearing Indicators and an ADF needle gauge, so you can select between the two and have one or the other. Just click the control box at the upper right corner of the ADF radio. The instrument in the lower OBI gauge position will toggle between an ADF and VOR gauge.

Communications Radio

Use the COM radio to tune into ATIS for weather, airport, and approach information. The charts provided with this manual show the ATIS frequencies for each airport where this service is available. The same procedure that is used

to set NAV radio frequencies is used to set the COM radio, except that you point at the COM radios's digits.

Transponder
On occasion, Air Traffic Control (ATC) will ask you to transmit a four-digit code or "squawk". The message from ATC will appear in a message window. To set the transponder, click the digit you want to change. The four digits are adjusted separately.

Altimeter Calibration
To set the altimeter to the current barometric pressure (to calibrate it), click the altimeter's adjustment knob. The altitude reading may change when you do this. You should do this a couple times each hour in advanced flight modes to ensure accurate altimeter readings.

Heading Indicator Calibration
Clicking the adjustment knob on the directional gyro sets the heading indicator to the same reading as the magnetic compass. (The magnetic compass does not drift with time as the heading indicator does, and it will always show a correct reading when "settled down" after a turn.) Always be sure the magnetic compass has settled down to avoid setting an incorrect direction.

FLYING THE AIRCRAFT

The single-engine aircraft simulation attempts to accurately simulate the actions and responses of a real aircraft. The Flight Simulator II aircraft is closely patterned after a Cessna Turbo Skylane RG II (basically a 182 with retractable landing gear, turbocharged engine, and other performance modifications). Some of the engine and prop control complexities are not included in the simulation. The INFO menu presents this aircraft's performance specifications.

When the simulator is started, the aircraft is on the ground on runway 27 Right at Oakland International Airport in Oakland, California. The plane is on runway 27 (indicating a 270-degree heading) facing west. The engine is running and the plane is cleared for immediate takeoff. At this time, navigation is secondary to flight control. This section explains how to get into the air, maneuver the plane, and land.

FLIGHT UNDER VFR CONDITIONS

On startup, the weather is fair. The sky is blue and the ground green indicating a clear day without a cloud in the sky. No winds are present. This is perfect weather for VFR (Visual Flight Rule) flying. A pilot flying VFR (as opposed to flying IFR under Instrument Flight Rules) makes only moderate use of the flight instruments and relies on ground references and the visible horizon for aircraft navigation and orientation. The most important instruments on your first VFR flight are the airspeed indicator and altimeter. The aileron, rudder, elevator, and throttle position-indicators are also important. Other instruments take on importance later, but for the first flight, we will be concerned with what is seen out the window and how it relates to altitude, airspeed, bank, and pitch attitude.

GETTING FAMILIAR WITH THE AIRCRAFT

If this is your first time in the plane, it is time to get familiar with it. Notice your altitude. Altitude is measured as feet above sea level, and although you are sitting on the ground, the altimeter reads the airport elevation of 7 feet above sea level. Oakland is near sea level so the elevation effect is small, but at Denver

Stapleton International (a high elevation airport), the altitude would read 5333 feet while on the ground.

Notice the compass and gyro compass. They have similar but seldom identical readings. The compass is read in degrees. A 270-degree reading corresponds to the aircraft pointing west.

It is visually obvious when the aircraft is standing still. The airspeed indicator is at its minimum position (readings don't start until 40 knots) and everything in the 3D display is still. When the aircraft is still, you can experiment with control movement. Turn the yoke full left then full right (move the mouse to the left and right while in yoke mode). Also try the elevator (mouse forward and back), rudder pedals (keypad [0] and [.] keys) and centering control (keypad [5] key). Don't try the throttle yet.

Now is a good time to try the view selector. You are initially looking straight ahead. To look to the right-front side, press the [Y] key. Figure 8 outlines the view selector keys. The view selector keys are positioned around the [G] key. Try pressing the keys around the [G] key, and watch the view direction change. You must be aware of the view direction you have selected in order to keep from getting disoriented. It's a good idea to always revert to front view before getting involved with other flying tasks (adjusting NAV radios, setting up an approach to landing, etc.).

The map display is a valuable aid when on the ground. It can guide you around airports and help with navigation in general. Select the map display by pressing the [F3] key. Press the [+], [-], [F9], and [F10] keys to zoom in and out. Press the [F3] key twice rapidly to turn off the map display. The MAP DISPLAY and MAP ZOOM menu items may be used instead of the [F3], [+], [-], [F9], and [F10] keys if you prefer. Click and hold on the zoom boxes for large zoom changes.

Check the view of your plane from the control tower by pressing the [C] key. Use the [F9] and [F10] keys to zoom in and out. Notice that the title bar indicates TOWER view. Return to cockpit view by pressing the [X] key. Notice that there is no title bar in cockpit view.

TAXIING

When on the ground you are, unfortunately, at the point of the flight where the 3D out-the-window display is at its worst. This is due to the limited vertical resolution of the screen. While on the ground, everything gets cluttered on the horizon because most objects are viewed edge-on. It is often hard to make out taxiways until you are close to them. Map view is quite useful when taxiing.

Begin taxiing by applying a bit of throttle (switch to yoke mode if necessary, then hold the left button down and move the mouse forward half an inch). Notice the movement of the throttle indicator on the instrument panel. In the 3D display, you will notice things start to move. The map view shows a top-down view of where you are headed.

Try turning the plane from left to right (move the mouse left and right). The rudder ground-steers the plane by controlling the aircraft's nose wheel, and the plane can be steered like a car using the rudder pedals. (NOTE: the plane is in auto-coordinated flight mode, so the aileron is linked to the rudder. Normally, you would have to use the rudder pedals to ground-steer). If the throttle is cut, the plane will eventually roll to a stop. If you require a quicker stop, use the brakes (hold the left button down and move the mouse to the left). You must be moving to turn the airplane. Practice taxiing around the airport to get an idea of what low-level scenery looks like.

PRE-TAKEOFF CHECK

Once you are familiar with taxiing, it is time to take off, but first you must do your pre-takeoff check. Go to the end of the runway, point down the runway, and line the plane up with the center line. Reduce throttle to zero and coast to a stop (use the brakes when necessary). Now, go through this checklist:

Pre-Takeoff Check List

1. Check for proper elevator operation. Move the elevator up and down and center it.
2. Check the rudder and ailerons in the same way. Center them.

3. Check the engine gauges. Make sure that the oil pressure and temperature are correct and that you have plenty of fuel. Check the heading indicator against the magnetic compass and set it if necessary (click the heading indicator knob).

NOTE: A checklist used in a real aircraft has many more steps than this one. It's hard to remember all the steps for safe startups, takeoffs, and landings. The aircraft manufacturer provides many check lists with the aircraft, and it's good to get into the habit of always using them.

TAKEOFF

It may be a good idea to read the following sections on climbs, glides, and turns before takeoff, but because this is a simulator, you may just take off now and cross those bridges as you come to them. (Use the pause [P] key any time you need to stop and read the manual.)

If you are ready, here goes. Get ready to steer the plane as it rolls down the runway. Small adjustments in steering are preferable to wild zig-zagging. Now - FULL THROTTLE. Keep the plane on the runway. You should be looking out the front windshield. Keep half an eye on the airspeed indicator. It will start to rise. When you reach 48 to 53 knots you can begin your rotation (the point where you start to pull back the yoke and raise the nose to put the plane in its climb attitude to get off the ground). About two notches of nose up (elevator up, pull back on the yoke) is about right. You will notice the runway drop away as you lift off, and the vertical velocity indicator start to show a positive reading. You are airborne.

CLIMBING

The FS2 has the stability of a real aircraft when climbing. It essentially climbs by itself without the need for constant adjustments. After takeoff with full throttle and a notch or two of up elevator the plane should be in a steady climb.

When climbing, you can increase your rate of climb by increasing the throttle setting (assuming you you are not at full throttle already) while holding a constant airspeed with the elevator. If you increase the throttle setting without

raising the nose, your airspeed instead of your climb rate increases. By raising the elevator, you convert airspeed into vertical velocity.

The relationship between speed, vertical velocity, elevator and throttle is complex. Practice flights will get you familiar with the characteristics.

Non-pilots are cautioned against trying to attain an increased or decreased climb rate by merely pulling back or pushing in the yoke without adjusting throttle appropriately to keep airspeed steady. Raising the elevator alone will indeed increase your climb rate for a few seconds, but soon your airspeed will drop as you lose momentum and you will either stall or drop to a dangerously low airspeed. Down elevator alone will put you into a screaming dive.

STRAIGHT AND LEVEL, CONSTANT-ALTITUDE FLIGHT

Again, the FS2 acts as a real aircraft when in straight and level flight. The most common problem in holding a constant altitude is slowly drifting from your desired altitude by getting careless and not checking the altimeter once in a while.

The transition from climb or glide to straight and level flight should be gradual. Use elevator and throttle to gradually get desired speed with no climb or drop. Don't chase the vertical velocity indicator. This can get you into trouble. After making small corrections using the altimeter and airspeed indicator as guides, you will find that your vertical velocity settles down nicely to near zero.

GLIDES AND DESCENTS

Glides and descents are used to reduce altitude with little or no engine power. Proper glide technique is essential for performing landing approaches.

In a climb, you increase throttle and raise the elevator to increase altitude, so it seems logical that you would want to lower the elevator and decrease throttle for a glide. This is not the proper procedure. By decreasing throttle, the plane naturally tends to drop its nose too far. Airspeed will start to rise if you decrease throttle and hold a straight and level elevator position (or lower the elevator) and decrease throttle. Again, your elevator should be used to hold your airspeed

constant at the desired glide speed. A bit of back pressure on the yoke (up elevator) should be used to keep the nose from dropping.

Judging how much up elevator to use takes experience. You have to learn to watch the world outside when you decrease throttle. Get to know your pitch attitudes in glides.

To practice glides, go up to five or six thousand feet, get straight and level, cut throttle to zero, and see what happens. If your airspeed gets dangerously high (over 140 knots or so) give a notch of up elevator. Raise the nose to get out of the dive you are in.

Flaps are useful during descents. Lowering the flaps provides extra lift and increases drag. You can increase your glide angle using flaps, which is useful if you are too high. Flaps also decrease stall speed, which also is desirable while making an approach and landing. Click on the flap position boxes in the "FLAPS" icon on the instrument panel to apply flaps as needed.

TURNS

The FS2 in self-coordinated flight mode automatically links ailerons and rudder thereby making turns simpler than in most real aircraft. The thing to remember about turns is that banking causes the turn. The aileron/rudder controls cause the plane to go into a bank.

Try a turn. Get into straight and level flight. Give a little left aileron. You will start to bank. Wait until the horizon appears to be banked 10 to 20 degrees. Now center the rudder/aileron. You are now in a turn. You will remain in the turn until you "roll-out" of it. The FS2 is positively stable and wing dihedral effects are considered, so the plane will gradually straighten itself out if a roll-out isn't manually performed.

Roll-out timing is important. If you want to get on a heading of 180 degrees, you must start to roll out of the turn (by giving right aileron/rudder) about 10 degrees before 180 degrees is reached. It takes time to get level again and while in the process of leveling off you are still turning.

A 10- or 20-degree bank is a shallow turn. After the turn, look at your altimeter. You may have lost a bit of altitude. In turns, planes tend to lose altitude, and the

steeper the bank, the worse it gets. A bit of up elevator while in a turn solves this problem.

LANDING

The hardest aspect of flying is landing safely and correctly. The idea of landing is to fly the plane a foot or two above the runway's surface and slow down until the plane stalls and stops flying. As the plane slows down, the nose will want to drop and the plane will try to fly itself onto the ground, but you must compensate with the elevator to keep the plane at the one or two-foot level until it stalls. If you fly the plane onto the ground above stall speed, it may bounce.

As you pull back the yoke, the plane will take a higher and higher nose-up attitude. This is good. When you finally touch down, your elevator will be nearly all the way up.

You will know when you touch the ground. The scenery outside will level off and there will be an appropriate sound.

The process of getting to level flight above and aligned with the runway takes some practice. Steep glides are preferred as you come in for a landing. An engine failure while in a steep glide will have little effect on where you land whereas an engine failure on a long, shallow, power glide at treetop level will drop you into the field half a mile from the airport. The idea is to align yourself with the runway and glide toward it in a steep glide at approach speed (about 75 knots indicated airspeed and 66 knots with flaps extended on final approach). You must then break the glide and transition into straight and level, power-off flight a few feet above the runway. This transition is known as the "flare".

You will use aileron and rudder to align yourself with the runway as you come in for a landing, but make sure that the aircraft and rudder are straight when you touch down. If they are not, ground steering will whip you off the runway because your wheels aren't aligned to make the plane go straight. An abrupt turning of the plane on the ground is known as a "ground-loop", and could severely damage a real aircraft.

Once on the ground, you can use brakes to bleed off extra speed and come to a stop. You will then be ready for your next flight. You may wish to taxi to the ramp area to top off the tanks and turn around.

Before taking off again, make sure to do the pre-takeoff check. You will usually find that you have to center the elevator which is nearly all the way up from the last landing. Taking off with full up elevator and full throttle can be disastrous.

AIRCRAFT REFUELING AND SERVICING

All the airports (except for the very small, single-runway grass strips) have fuel and servicing facilities. Fuel and servicing areas are marked by rectangles with "F"s inside them. These areas are found at the airports' ramp area. To refuel and have your aircraft serviced, come to a full stop within one of these areas.

FLYING THE BUSINESS JET

The business jet simulation allows you to fly up to 45,000 feet at speeds up to 445 knots (Mach .8). This mode is not as realistic as the single engine prop aircraft, but it is a lot of fun and lets you go places and view scenery very quickly.

FLIGHT CHARACTERISTICS

The performance characteristics of this simulation closely match those of a Gates Learjet 25g twin turbojet aircraft.

The INFO menu gives the performance specifications. The major lack of realism is in the area of flight instruments and controls.

Instruments

A Learjet has two engines and thus two sets of engine instruments. Because they are turbojet engines, their instruments are different than those of a piston engine. Instead of two sets of the proper temperature, exhaust pressure ratio (EPR), and fuel-flow gauges, the single engine prop's instruments are used.

The tachometer is recalibrated to show percent of full RPM rather than absolute RPM.

The airspeed indicator is recalibrated to read speeds of up to Mach 1 (the speed of sound, 740 mph at sea level). The airspeed indicator reads out the true speed rather than traditional airspeed based on airflow. Indicated airspeed corresponds fairly well to true airspeed on slow aircraft, but on a jet at 45,000 feet at near the speed of sound, indicated airspeed is usually just a few hundred knots due to the low air density. The true airspeed indicator gives a better indication of how fast you are really moving.

The rest of the instruments are the same as in the prop aircraft mode.

Controls

The controls are basically the same as on the prop aircraft. The engines responds more slowly to throttle input because the jet engines need time to "spool up" to speed.

The aileron and rudder sensitivity is a bit higher, and the aileron can sometimes "get away" from you if the plane gets out of control. This is indicated by the aileron indicator moving wildly with no mouse control.

FLYING TECHNIQUES

There are three things to remember when flying the business jet: fly it with a light touch, remember that your aircraft is heavy and has a lot of inertia, and most importantly, don't exceed the Mach maximum operating speed (Mmo).

The Learjet 25g has a maximum takeoff weight of 16,300 pounds (as compared to the Cessna Turbo RG II's 3100 pounds). Once an aircraft that is this heavy is on a given course and speed, it takes a lot of effort to slow it down or change its direction of flight. This is particularly true on landings. The best way to land the aircraft is to reach the runway numbers with just the proper speed and rate of sink. If you come in too fast you will float above the runway as the plane bleeds off speed. If your rate of sink is too high, you will hit the runway hard. If your sink rate is too high, extra rotation as you near the runway won't help - it will just change the attitude you are in when you smash into the runway.

The Learjet is a very streamlined plane, and its two General Electric CJ610-8A turbojets are very powerful engines. The biggest problem you will run into in this plane is too much speed. The Mach maximum operating speed is Mach .82 and is indicated on the airspeed indicator. If you exceed it, the overspeed warning system is activated. If you don't take action and reduce power, climb, or use spoilers (flaps) to get the speed down, the "stick puller" pulls up the nose a bit to slow the plane down.

The overspeed dangers can not be over-emphasized. This plane is so powerful that you can easily exceed Mmo in level flight with full throttle. If you let the plane get too much overspeed, supersonic shock waves travel back on the wings until they reach the ailerons. Since the aircraft uses mechanical linkage controls, the yoke (as shown by the aileron indicator) begins to buzz and shake wildly from side to side. At this stage you are out of control.

Don't be tempted to activate the spoilers to slow down if you are overspeed and out of control. They will just drop the nose and make you go faster, putting you in a worse situation yet. Recover by pulling the power off and gently pulling back on the yoke. Too much yoke pressure will increase the wing loading,

moving the shock wave back and making the controls shake even more violently. If all else fails, lower the landing gear. The Learjet is able to withstand the forces of gear down at high speed with only minor gear door damage. The gear adds drag and helps stabilize the plane. It should slow you enough to regain control and fly back to the airport to have your plane inspected and repaired if necessary.

ENVIRONMENT CONTROL

ENVIRONMENTAL CONTROL controls flight factors that are external to the aircraft. These include seasons, time of day, clouds, wind, and turbulence.

MENU OPTIONS

Figure 11 shows the menu bar and ENVIRONMENTAL CONTROL menu. To adjust environmental factors, point to the menu bar and select the appropriate option on the menu.

SELECTING SEASON

The WINTER, SPRING, SUMMER, and FALL menu items can be selected to specify the season. Only one is active at a time, and the check mark to the left shows the current season. Season sets weather conditions that are typical of the specified season.

Each season presents unique flying problems. Winter brings icy runways and startup problems. Summer brings hot, humid days that increase density altitude and reduce lift. Each situation requires different skills.

SETTING TIME OF DAY

Set the time of day by clicking the digits on the "TIME" clock on the instrument panel (see Figure 11d).

The FS2 operates in three distinct visual flight periods: day, dusk/dawn, and night. The visual flight period is selected automatically based on the time of day. The clock is a 24-hour clock to allow consideration of AM and PM times. The visual mode switch-over transition times are:

Season	Night to Dawn	Dawn to Day	Day to Dusk	Dusk to Night
WINTER	7:00	7:30	17:00	17:30
SPRING	6:00	6:30	19:00	19:30
SUMMER	5:00	5:30	21:00	21:30
FALL	6:00	6:30	19:00	19:30

SETTING CLOUD LEVELS

Selecting CLOUDS on the ENVIRO menu will activate the dialog box for cloud adjustment show in Figure 11b. There are two setable cloud layers, and ground fog.

Set the top two cloud levels by clicking on the control box next to the words TOPS and BASE, and enter the cloud digits using the keyboard.

The top two cloud layers' altitudes are measured in feet above sea level (MSL). The gauge to the left of the Cloud icons shows the cloud altitudes.

Set the depth of the ground fog by clicking on the DEPTH control box and entering the digits. Ground fog always starts on the ground, and its depth is measured in feet above ground level (AGL).

To eliminate cloud layers and ground fog, click on the control box next to the LEVEL marker.

To exit the CLOUDS dialog box, click on the CLOSE box in the upper left corner of the window.

SETTING WIND AND TURBULENCE

Selecting WINDS on the ENVIRO menu will activate the dialog box for wind adjustment shown in Figure 11c. There are three setable wind levels, and surface wind.

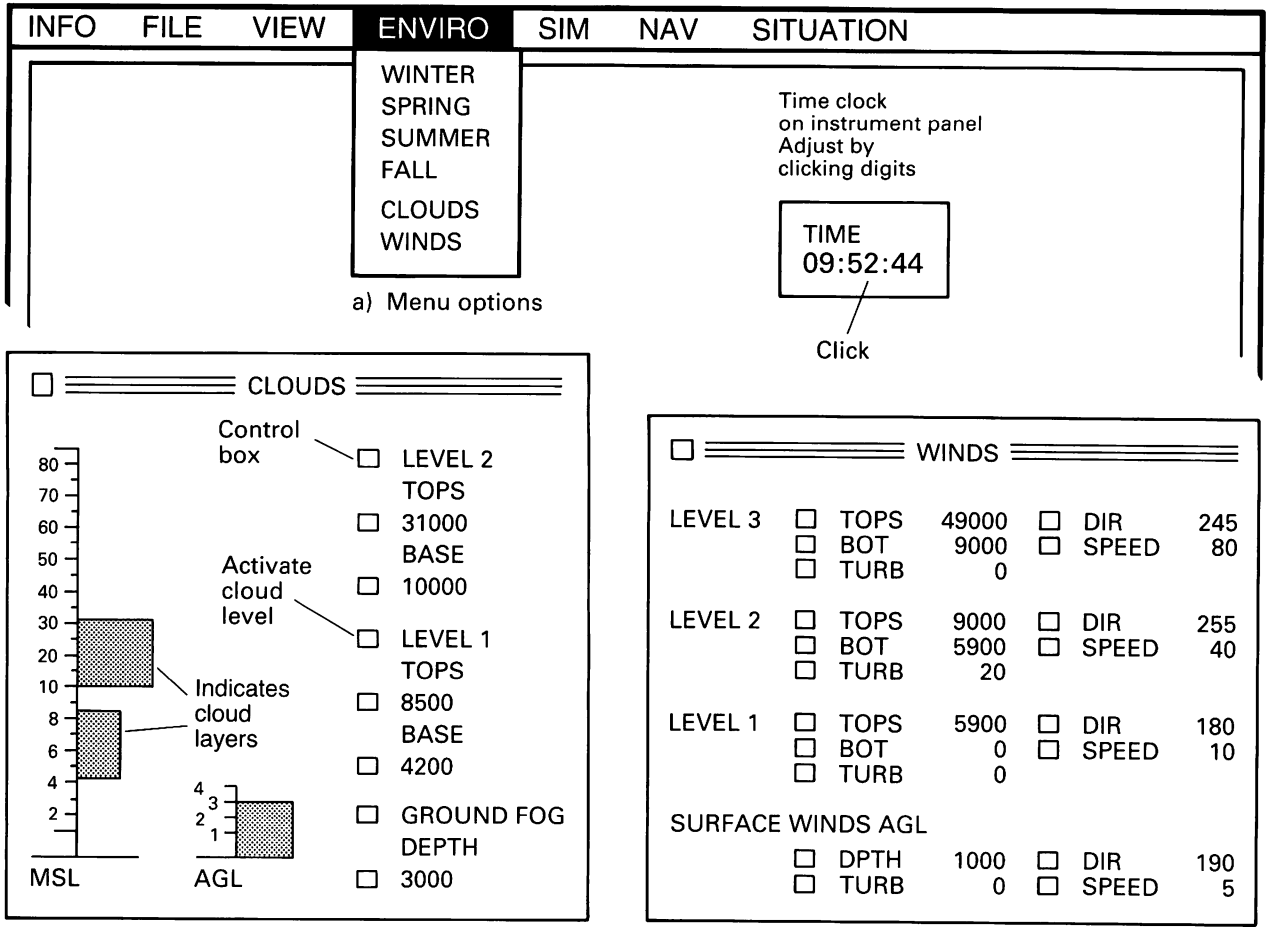


Figure 11. Environmental Controls

To enter digits in the WINDS menu, click on the desired control box and type in the digits followed by [Return]. You may also use the cursor keys to move between items.

You can set surface wind to simulate realistic takeoff conditions by setting surface wind velocity (SPEED), direction (DIR), and DEPTH. Surface winds are encountered from ground level up to the altitude above ground level specified as DEPTH. Surface wind direction is specified as magnetic direction.

Three levels of "winds aloft" are available. Set the values of BOT (bottom, the altitude at which the winds begin), TOP (the altitude at which the winds cease), DIR (direction), and SPEED. Wind direction for winds aloft is true direction (not magnetic), and altitude is specified as feet above sea level (MSL).

Turbulence (TURB) has a range of 0 to 10. Zero indicates smooth air, while ten is the most severe turbulence setting.

To exit the WINDS dialog box, click on the window's CLOSE box.

SIMULATION CONTROL

SIMULATION CONTROL controls flight factors that are internal to the aircraft and the Flight Simulator II system. These include realism adjustments, communication rate, reliability, pause, and other internal effects.

MENU OPTIONS

Figure 12 shows the menu bar and SIMULATION CONTROL menu. To adjust simulation factors, point to the menu bar and select the appropriate option on the menu.

SOUND

Sound can be toggled on and off by clicking SOUND on the menu. The check beside SOUND indicates that the sound is on. It is more convenient to use the [Tab] key to turn sound on and off.

PAUSE AND CURSOR PAUSE

You can pause and un-pause the simulation by clicking on PAUSE. A check next to PAUSE indicates that the simulation is paused. The [P] key can also be used to pause, and is usually more convenient.

The PAUSE IN CURSOR mode can be set by clicking on the menu. A check next to the menu item indicates that this mode is active. When in PAUSE IN CURSOR mode, the simulation will automatically pause whenever you put the mouse into cursor mode. The simulation will only fly along when the mouse is in yoke mode. This gives you more time to select menus and choose from menus because you don't have to worry about aircraft control while making selections. This feature, however, detracts from the real-time realism of the simulation, so you can leave it turned off if you prefer.

AUTO-COORDINATION

This feature links and unlinks ailerons and rudder. When a check appears next to AUTO COORD, the rudder and aileron are linked. Flying in uncoordinated mode (no check next to AUTO-COORD) requires that you use the rudder pedals (the [0] and [.] keypad keys) as well as the ailerons to fly. This is a more difficult mode to fly in, but it allows you to perform maneuvers that are not possible while in coordinated modes. See the ADVANCED FLIGHT TECHNIQUES section for details on how to perform these maneuvers.

RELIABILITY

When menu item RELIABILITY is selected, the dialog box shown in Figure 12b appears. The sliding pointer can be dragged using the mouse to the desired aircraft reliability setting. The value represents the probability of the plane running reliably. A value of 100 ensures a totally reliable aircraft, while a value of zero presents frequent problems (instrument failures, engine problems, fuel system problems, etc.)

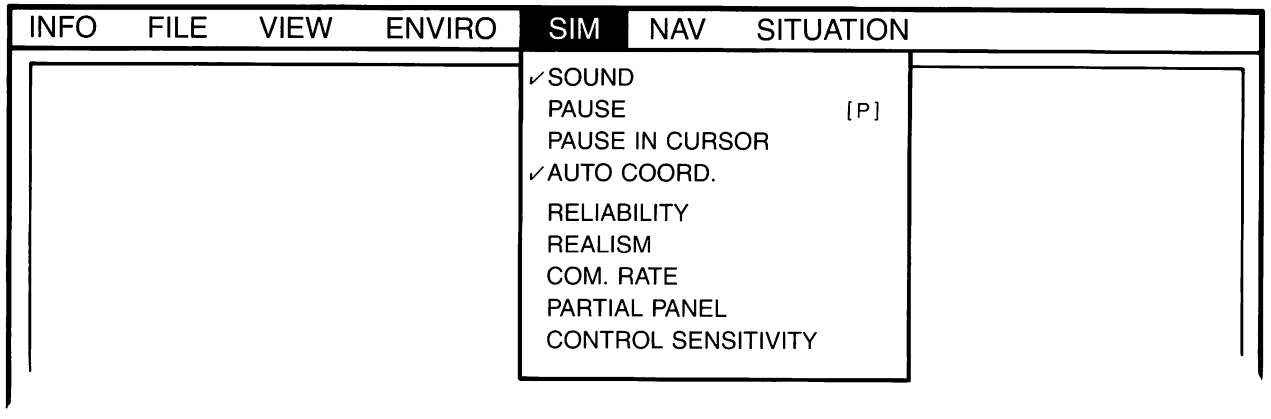
REALISM

When menu item REALISM is selected, the dialog box shown in Figure 12c appears. You can turn the effects you desire on and off by clicking on the control boxes next to the items. Turning on these reality effects add more complexity to the simulation and make it harder to fly.

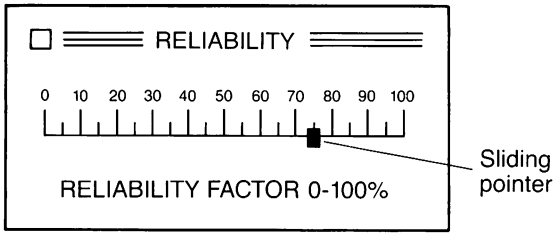
Engine
Refers to the need to use the magneto switch to start the airplane.

Fast Throttle
Gives the engine a chance of bogging down and dying if you increase your throttle too quickly.

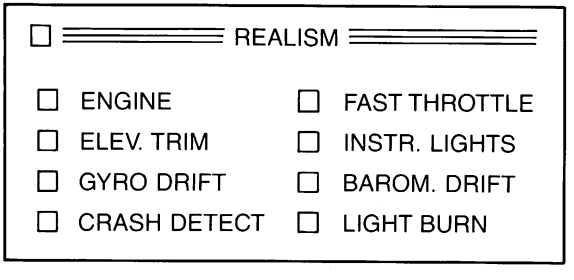
Elevator Trim
Activates the elevator trim control and causes the elevator position to drift toward a setting that is determined by the aerodynamic conditions and the



a) Simulation menu options



b) Reliability dialog box



c) Realism dialog box

Figure 12. Simulation Controls

elevator trim setting. You constantly have to adjust the elevators unless you trim the plane properly when this effect is set.

Instr Light
Makes your panel go blank at night unless you turn your lights on.

Gyro and Barom Drift
Causes the selected instrument to drift as time goes by. You should get into the habit of occasionally adjusting these instruments while in flight, and this effect creates bad consequences if you don't.

Crash Detect
Enables aircraft crash detection. If crash detection is turned off, the plane will "bounce" when it hits the ground.

Light Burn
Causes lights to occasionally burn out. Flying with your lights on during the day can cause this to happen.

PARTIAL PANEL

Clicking on PARTIAL PANEL presents a menu with a list of flight instruments with control boxes next to them. Clicking on the control boxes blanks the selected instruments so you can fly with limited instrumentation (flying "partial panel"). It is good flight training to fly without key instruments and by visual references only. It gives you an idea of what to expect if you have an instrument failure.

CONTROL SENSITIVITY

Selecting this item presents a dialog box that contains five sliding sensitivity controls that you can adjust with the cursor. Aileron, elevator, throttle, and brake sensitivity can be adjusted. The markings next to the sliding indicators indicate how many inches the mouse must move to deflect the controls through their entire range.

The fifth slider controls NULL ZONE size. In order to keep the plane from slowly drifting into a bank if the ailerons are positioned the slightest bit off-center, a null zone in the center of control movement is provided. As long as the mouse is in this zone, the ailerons are centered. Too wide a null zone gives the ailerons a sloppy feel, while too small a zone makes it too easy to unintentionally start banking. Adjust this to the balance between these two conditions you like the best.

NAVIGATION

This section describes the Flight Simulator II "world" and how to get around in it. First the map display, a vital tool in navigation is described. Then the organization of the world and how to move quickly around it without flying is discussed. Finally the autopilot, a valuable navigational tool is covered.

MAP DISPLAY OPTIONS AND CONTROL

Pressing the [F3] key or clicking on MAP DISPLAY in the NAV menu (see Figure 13) turns on a map of the area over which you are flying. This window can be expanded and moved using its title bar and SIZE box. The check mark next to MAP DISPLAY on the menu indicates the map on/off status. Turn the map off by pressing [F3] twice sequentially or by clicking on the MAP DISPLAY menu option.

You can zoom in on the map to look closely at airports (good for when taxiing), or zoom out to look at large areas to see where you are. Press the [F3] key followed by the [+] or [F9], [-] or [F10], and [Backspace] keys for zoom-in, zoom-out, and 1X display. Zoom control can also be performed using the MAP ZOOM option on the NAV menu (see Figure 13). Press the [F1] key to re-select the first 3D window.

The AIRCRAFT ORIENTATION and NORTH ORIENTATION items on the menu refer to the map's rotated positioning. If AIRCRAFT ORIENTATION is selected, the map will be rotated so the top center is in the direction you are flying. NORTH ORIENTATION positions the map with north at the top of the screen. In both cases, your aircraft's position is noted with an aircraft symbol at the center of the screen.

THE "WORLD" AND WORLD NAVIGATION

The "world" in which you fly has a range of approximately 10,000 by 10,000 miles with a resolution of about one one-hundredth of an inch, and a center coordinate (x=0, y=0) at 40 degrees latitude and 88 degrees 30 minutes longitude (about 30 miles south-west of Champaign, Illinois). The range covers the entire continental United States and extends well into Canada, Mexico and

the Caribbean. Airports and other features were digitized directly from aerial photographs or taxi charts when no photographs were available.

WORLD SPECIFICATIONS

The world database is currently limited to about 120 airports in 5 general areas (San Francisco, Seattle, Los Angeles, Boston/New York, and Chicago and central Illinois). The database is not very extensive considering the vast number of airports and topographic features in the United States and Canada, but everything that's there is in its proper place. Systems are provided to let you get from area to area quickly and easily. You could actually fly between distant points (Seattle to Los Angeles for instance) but it would take hours. In flight mode, flying this far is not possible due to fuel supply limitations, and there are no airports between distant points (at least not yet).

Charts 1-5 show the five general navigation areas.

GETTING AROUND IN THE WORLD

There are three ways to move around in the world: flying, slewing, and setting your coordinates manually.

Flying

This method is fine once you are in the general area you want to fly in.

Slewing

In slew mode, you can move the plane freely and quickly in 3D space using the mouse and and keyboard controls. You can change your heading, bank, and pitch. You can instantaneously stop the plane in mid air and look around.

Enter slew mode by selecting SLEW on the NAV menu. Slewing can be fully controlled from the keyboard. Some slew movement can be controlled by the mouse. Moving the mouse forward and backward accelerates you forward and backward. The more you move the mouse, the faster you will accelerate. Left and right mouse movement change the direction you are pointing. You can "steer" yourself as you move forward. Single-clicking the mouse stops all slew motion, while double-clicking returns you to cursor mode.

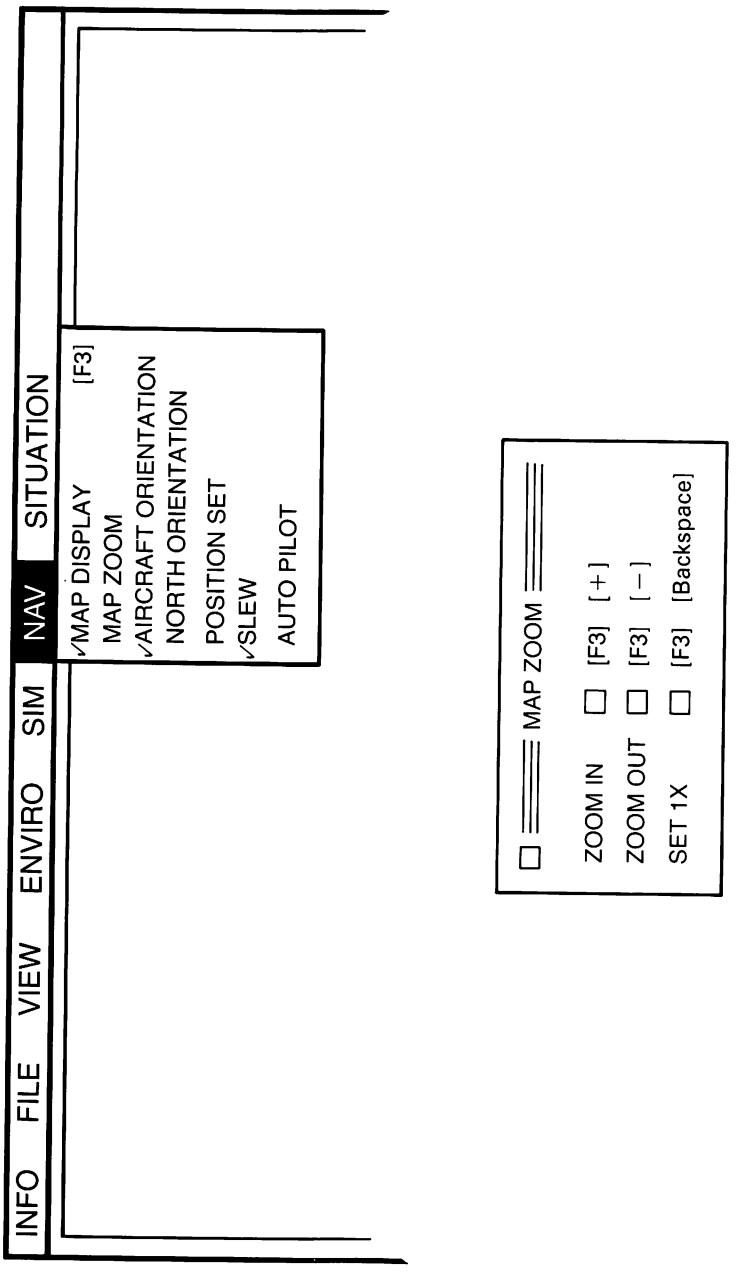


Figure 13. Navigation Menu Options

To control slew movement from the keyboard, use the numeric keypad. The [8] and [2] keys accelerate forward and backward. The [4] and [6] keys turn left and right. The [5] key stops all slew movement.

The following keys control other slew directions:

Key	Movement
<	left
>	right
Q	increase altitude
A	decrease altitude
(	pitch nose up
)	pitch nose down
[	left bank
]	right bank
Z	turn on/off NORTH and EAST digit readout

As you slew around, the values next to the NORTH and EAST parameters change to reflect your new position. When you resume flight, you will resume from the new north and east positions.

Exit slew mode by clicking on the SLEW item on the NAV menu. This will put you back into flight mode. Once in flight mode, the aircraft will continue doing what it was when you entered slew mode (flying, sitting on the ground, etc.). If you were previously on the ground and you slewed to a high altitude, exiting slew mode will cause the plane to fall out of the sky until it gets going fast enough to glide. Pitch, bank, and heading set during slew mode are transferred to flight mode. North, east, and altitude positions set in slew mode are also transferred to flight mode. You can slew to a new flight area and resume flight there.

Position Set

The third and fastest way to get to a precise destination is to select the POSITION SET item from the NAV menu and manually set your destination coordinates. North, east, and altitude coordinates can be set by clicking on the NORTH, EAST, or ALTITUDE box and typing in the desired value followed by [Return]. You can move between items by using the [cursor up] and [cursor down] keys.

North and East coordinates for many airports are shown on the navigation charts. Altitudes are also shown, but it is more convenient to just enter zero as the altitude. The simulator will automatically put you at field elevation when you get to the airport.

Your position is not put into effect until you exit from the POSITION SET menu.

The POSITION SET menu also lets you position the control tower view location. NORTH, EAST, and ALTITUDE next to the menu line TOWER specify the view location for tower views. Setting tower location does not place a visible control tower in the scenery.

NAVIGATIONAL AIDS

Flight Simulator II features five of the most commonly used navigational aids: VOR (Very high frequency Omnidirectional Range), DME (Distance Measuring Equipment), ADF (Automatic Direction Finder), and ILS (Instrument Landing System) are available for day or night flight. Airport beacons are provided at night.

VOR NAVIGATION

VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine what angle or what "radial" from the station you are on. Radials can be thought of as directional beams radiating outward from the VOR station like spokes of a wheel (see Figure 14).

The Omni-Bearing Indicator or VOR Indicator is a panel-mounted instrument (Reference Fig. 1, items 8 and 9) that lets you determine what VOR radial your plane is currently on, and helps you fly up and down radials toward or away from the VOR station.

The OBI consists of the following components (see Figure 14):

Course Deviation Indicator (CDI): A vertical needle that shows your deviation from the selected radial.

Course Selector: This is the numeric value that appears at the top of the OBI. This number shows what radial is selected.

Course Selector Knob or Omni-Bearing Selector: A knob that adjusts the course selector. This is used to select the radial you want to fly on, or to find what radial you are intercepting.

TO-FROM-OFF Indicator: This indicator shows whether the course selected in the course selector will take the aircraft TO or FROM the station. OFF indicates an out of range station or an abeam position (more than about 75 degrees away from the desired radial).

Here are a few important facts about VOR readings:

1. The VOR indicator only tells you what radial you are on. It says nothing about the direction the aircraft is flying.

2. As you turn the OBS knob, the needle will center twice - once with the TO flag showing, and once with the FROM flag showing.

3. When you adjust the OBS knob until the CDI needle centers, and the TO-FROM flag indicates FROM, you can read the radial number on the course selector (the top digits on the gauge).

4. When the needle is centered, the course selector shows the heading you must fly to go TO or FROM the VOR station (based on the TO-FROM flag).

5. When flying toward or away from a station, the CDI needle will move to the right of center if you are off course to the left of the radial. To get back on course, change your heading a bit to the right and "fly toward the needle".

6. On windy days, you will have to add a correction factor to the course selector heading to compensate for any crosswind that may tend to blow you away from the radial.

7. You can use the TO or FROM needle-centered position to fly to or from a station, but if you fly from a station with a TO flag showing, the CDI needle will be reverse-sensing (moving backwards if you get off course).

The best way to get a feel for VOR navigation is to go through a few practical examples:

Flying Toward a Station

1. Select a VOR station on the map and tune the NAV1 receiver to the station. Refer to Figure 15.

2. Adjust the OBS Omni-Bearing Selector (the knob on the upper VOR) until the TO-FROM flag reads TO. If the OFF flag appears for all OBI settings, you are either too far from the VOR station (station range is 30 to 100 miles) or the NAV1 radio is improperly tuned.

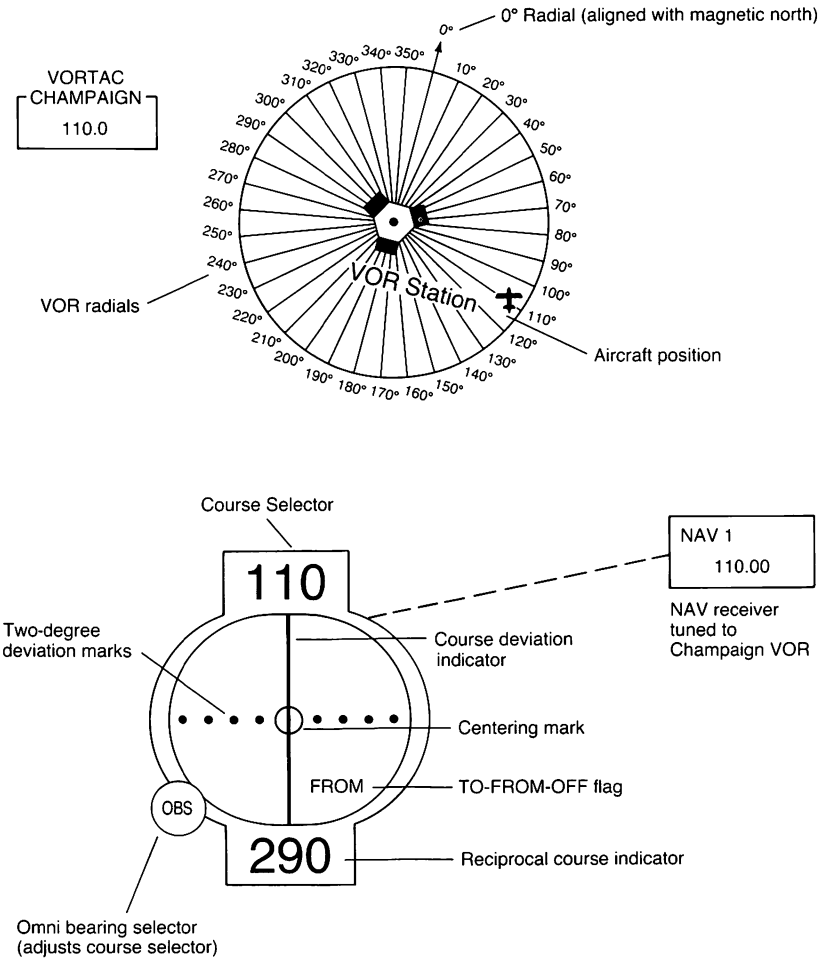


Figure 14. VOR Station, Radials, and Indicator

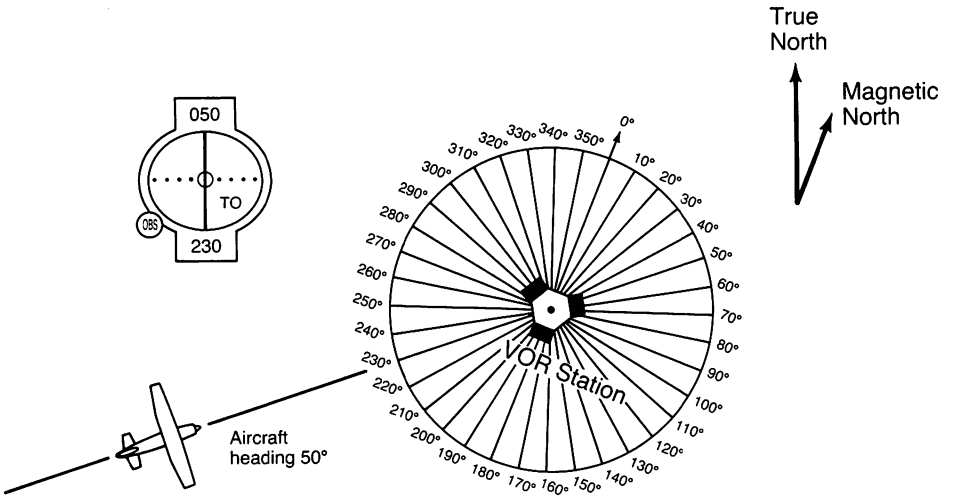


Figure 15. Flying to a VOR Station

3. Adjust the OBS until the CDI (vertical needle) is centered. Make sure the TO flag is still showing.

4. The magnetic course to fly TO the station can now be read on the course selector.

5. Take up the course indicated by the course selector. This will fly you right to the VOR station.

Flying Away from a Station:

1. Select a VOR station on the map and tune the NAV1 receiver to the station. Refer to Figure 16.

2. Adjust the OBS Omni-Bearing Selector (the knob on the upper VOR) until the TO-FROM flag reads FROM.

3. Adjust the OBS until the CDI (vertical needle) is centered. Make sure the FROM flag is still showing.

4. The magnetic course to fly FROM the station can now be read on the course selector.

5. Take up the course indicated by the course selector. This will fly you away from the VOR station.

Station Passage:

1. Select a VOR station that you want to fly past (TO on the selected radial and FROM on a radial of about 180 degrees difference). Tune it in, and fly TO it. Refer to Figure 17.

2. When you get very close to the station, the needle will become hard to track. Radials are close together near the station they radiate from, and even small course errors show large deviations.

3. Don't chase the needle or try to keep it centered. Instead, fly straight on the heading indicated on the OBI until you get to the other side of the station.

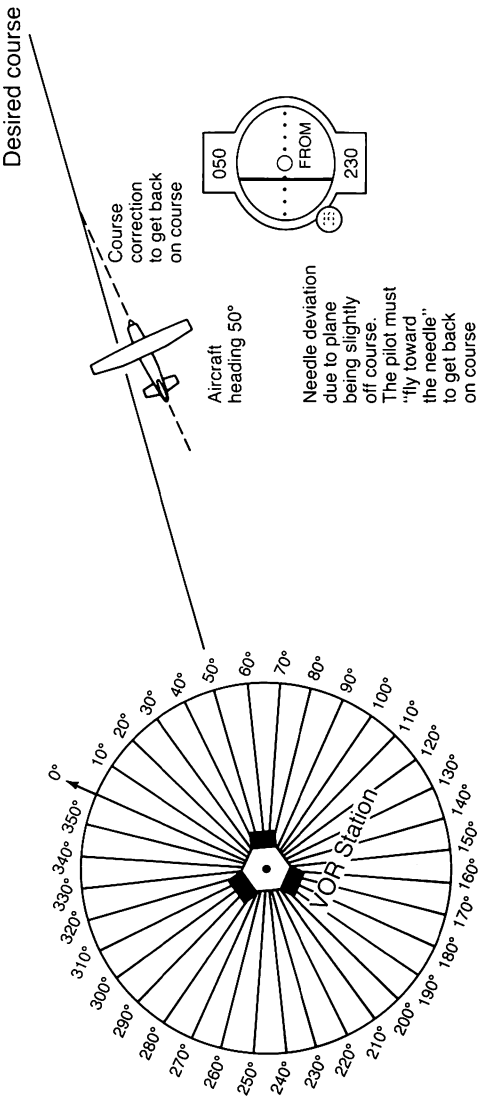


Figure 16. Flying from a VOR Station

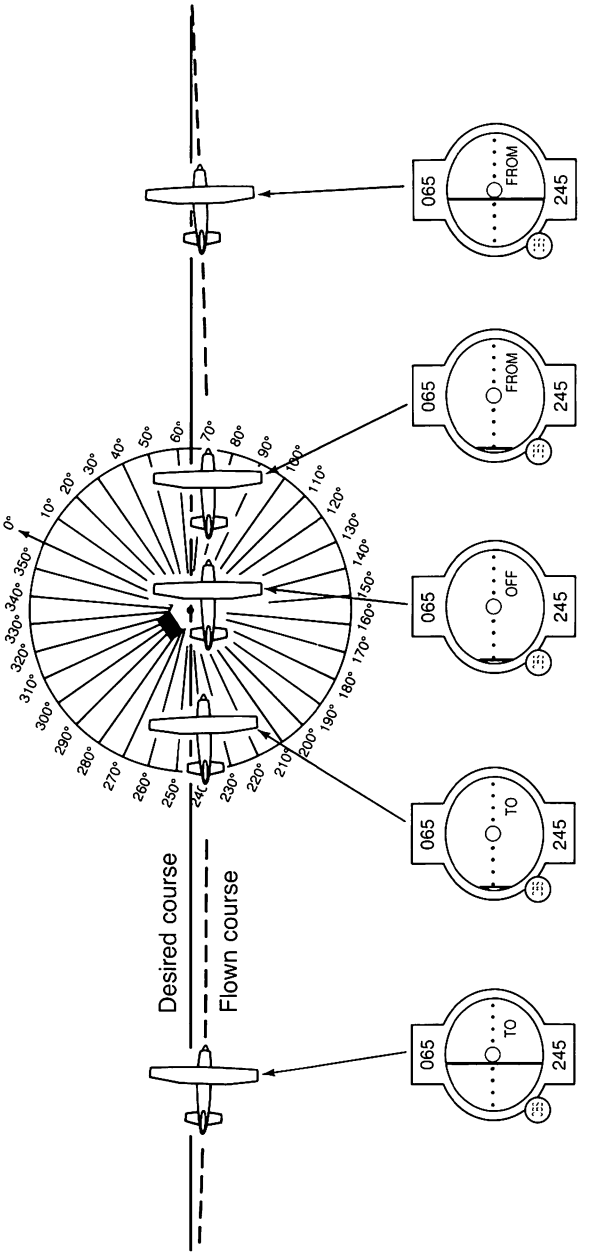


Figure 17. VOR Passage

4. You very rarely will fly right over a VOR station. If the station is a fair distance to the right or left of you (usually a mile or more), the OFF flag will appear indicating an abeam position and the CDI needle will pin itself to the side of the VOR gauge toward the station. You then know on which side of the station you are passing.

5. Shortly after station passage, the FROM flag will appear. Assuming you held your heading to the OBS course, the CDI needle will be nearly centered. You are now flying FROM the station as intended.

Crosschecking Position:

1. Tune in two different stations on NAV1 and NAV2.

2. Adjust the OBS knobs on VOR indicators 1 and 2 until the FROM flags are showing on both. Read the radials you are on for both stations.

3. Look at your navigation chart and draw lines down the radials of the two VORs. The intersection of the lines is your position (see Figure 18).

Flying from Station to Station:

1. Select two VOR stations that you want to fly between. You will be flying FROM station A TO station B. Draw a line on the map between them (see Figure 19).

2. Tune in station A on the NAV1 radio.

3. Adjust the OBS on the upper VOR until the course selector shows the course you wish to fly from station A. This value can be read off the VOR degree markings on the map.

4. Fly to the vicinity of station A and get on the radial and course just selected on the OBS. The FROM flag should appear.

5. Fly FROM the station as usual.

6. When you are far enough from the station that it is getting weak, or if station B is in range, tune in station B on NAV1.

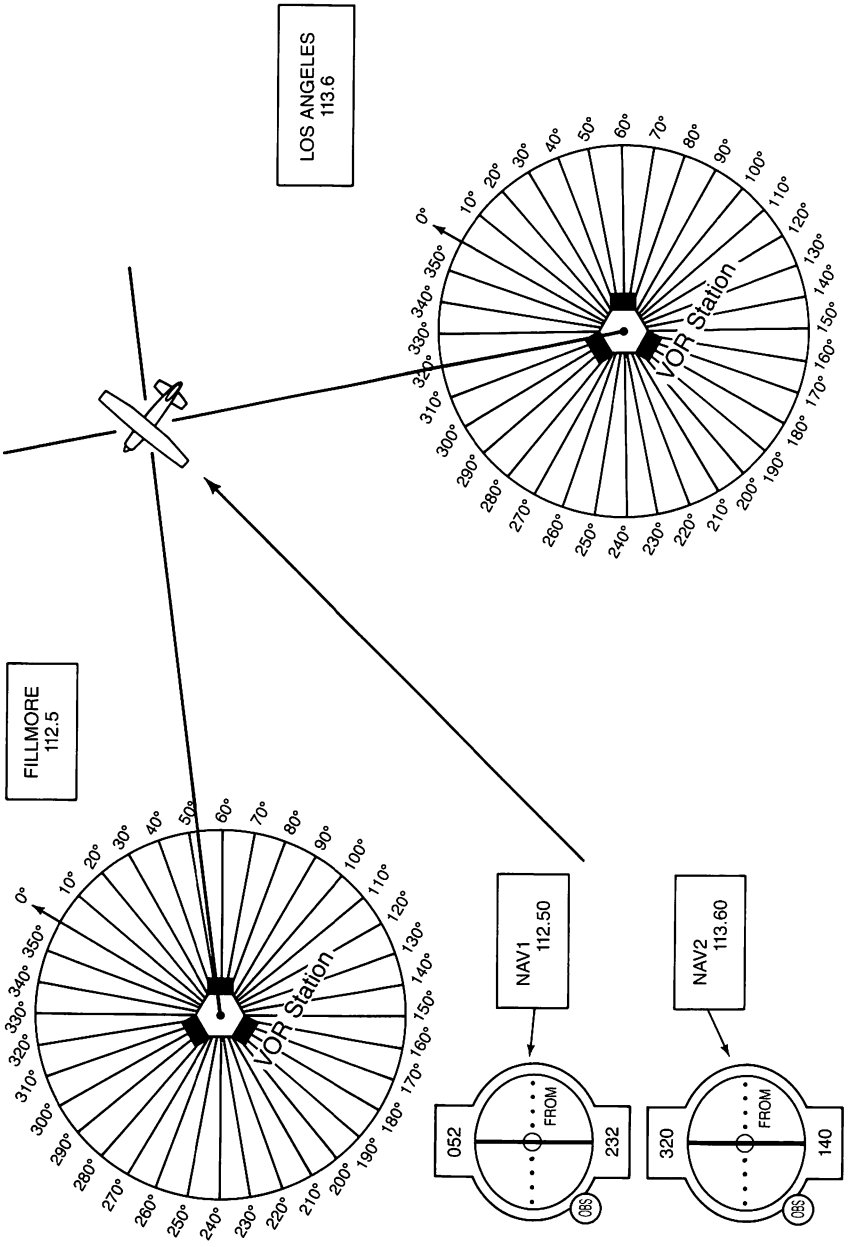


Figure 18. VOR Crosschecking

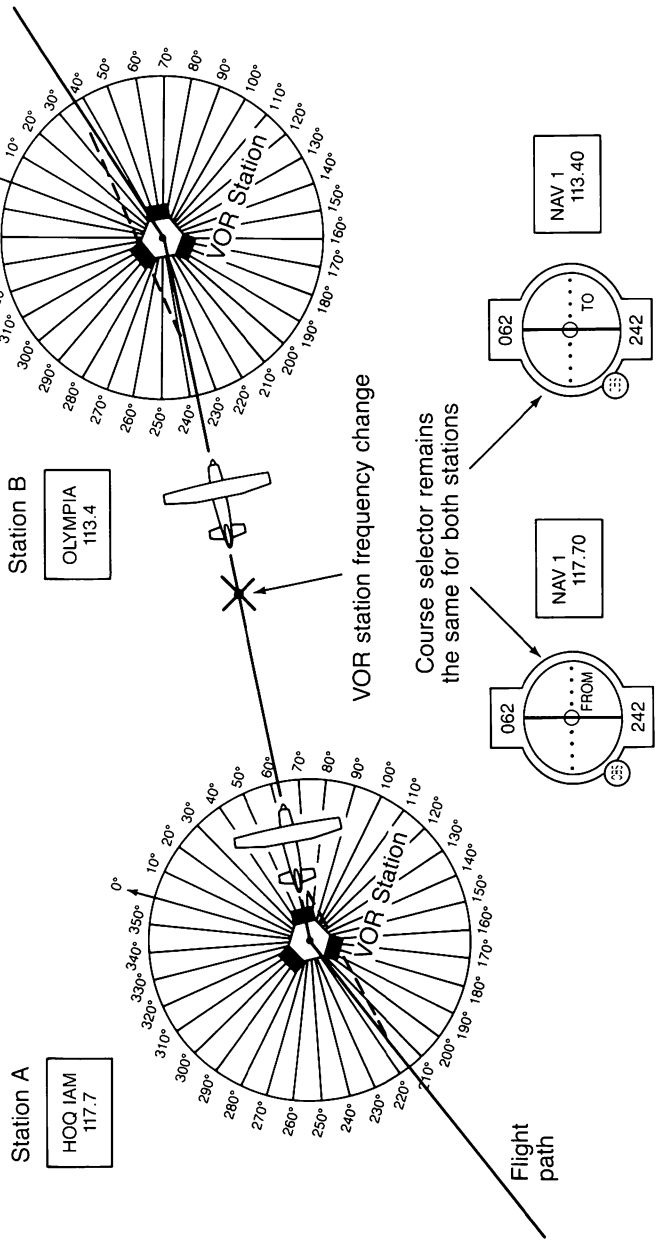


Figure 19. VOR Station-to-Station Navigation

7. Without adjusting the OBS, the TO flag should appear on VOR 1 and the CDI needle should be very nearly centered. Keep flying the course shown on the OBS TO station B.

DISTANCE MEASURING EQUIPMENT (DME) NAVIGATION

The DME receiver measures the distance in nautical miles to the VOR station tuned on NAV1. This information lets you pinpoint your position by finding your location on the tuned VOR's radial. The DME system usually has less range than the VOR receiver, so you may have no DME operation yet be receiving the VOR station. The DME digits are turned on only when the aircraft is within DME range of the VOR.

AUTOMATIC DIRECTION FINDER (ADF)

The Automatic Direction Finder (ADF) is used with non-directional radio beacons (NDBs). When the ADF receiver is tuned to an NDB, the needle on the bearing indicator (see Figure 20) points to the station, and shows the bearing relative to the nose of the aircraft (the relative bearing). The magnetic bearing to the station can be calculated by adding the relative bearing to the aircraft's magnetic heading.

Tracking and homing techniques can be used to fly to an NDB, but strong crosswinds require special procedures to avoid spiraling toward or a way from it. If you want to get some ADF tracking practice, turn on the ADF by clicking on the small selection box next to the ADF markings on the ADF radio. Turn up the winds using the WINDS menu, consult a flying handbook for the proper techniques, and try tracking an NDB.

INSTRUMENT LANDING SYSTEM (ILS)

ILS approaches are available at several airports. Consult your airport chart or tune in your COM radio to the ATIS frequency to determine if ILS is available.

The glideslope needle and the Outer, Middle, and Inner (OMI) marker lights are used for ILS approaches. They work just as they do in real aircraft. Refer to an instrument flying handbook such as the *Flight Training Handbook* for information on instrument approach techniques and how to use these instruments.

AIRPORT BEACONS

At night, you can spot airports by their flashing beacons. Civilian airports have beacons that alternate between green and white.

AUTOPILOT

On long cross country flights an autopilot is a good flight aid. It relieves a pilot of the tedious chore of holding a desired altitude and tracking a heading or VOR. This reduces fatigue and lets the pilot devote more time to other flight tasks (instrument scan, radio communications, preparing for an approach, etc.).

An autopilot's wing leveler (a separate system in many planes, but integrated with the autopilot in Flight Simulator II) keeps the wings as level as possible and keeps you from going into an undesired turn or roll. This is especially useful in turbulent conditions in clouds where, without keeping an eye on the attitude indicator continuously (hard to do while preparing for an instrument approach), you can end up in a steep bank or upside down and not even realize it until it has turned into an emergency situation.

To set the autopilot, select the AUTOPILOT option on the NAV menu. A dialog box with control boxes will appear as shown in Figure 21. The WING LEVELER and VOR 1 LOCK can be toggled on or off by clicking on their control boxes. HEADING LOCK and ALTITUDE LOCK will request a value when clicked. HEADING LOCK requires the heading in degrees that you want to track. ALTITUDE LOCK needs the altitude you want to maintain. You can turn any lock off by clicking on one of the control boxes in the OFF column.

The VOR 1 LOCK tracks the VOR radial that you have set on the Omni-Bearing Selector. A good way to setup the VOR 1 LOCK is to first track the VOR manually as described in the VOR Navigation section. Then select the autopilot

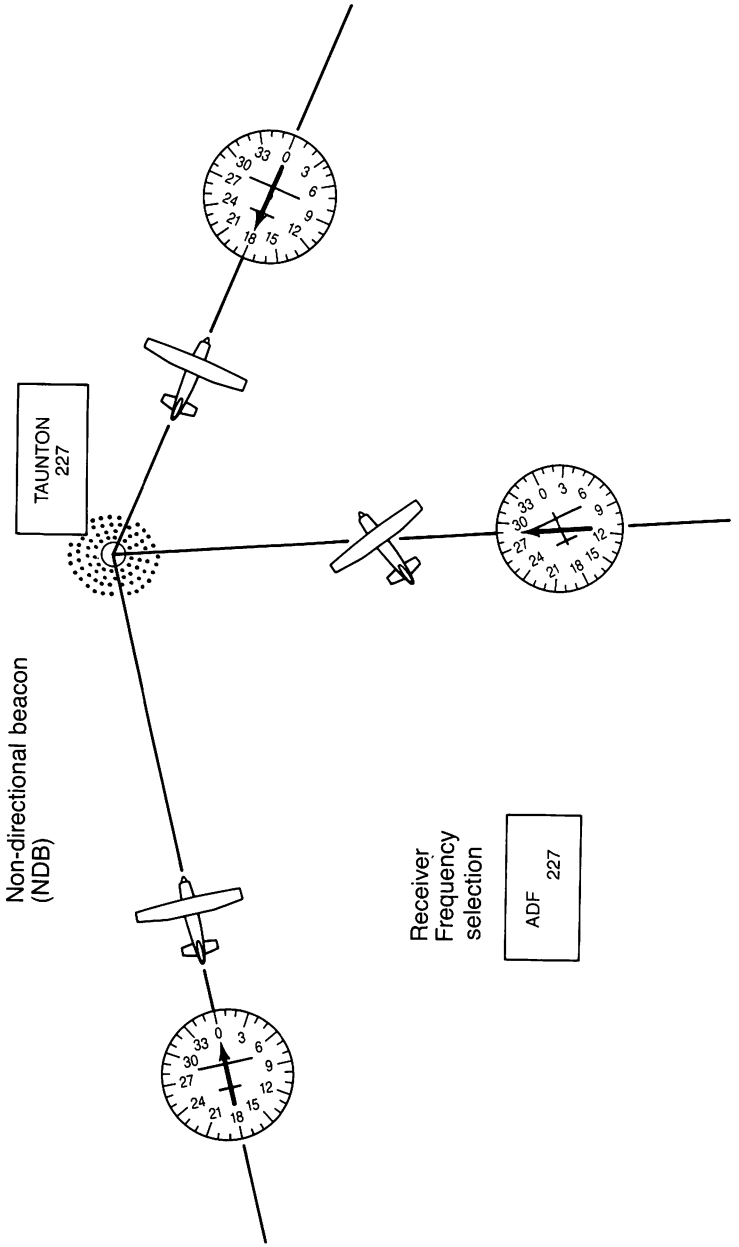


Figure 20. Automatic Direction Finder (ADF)

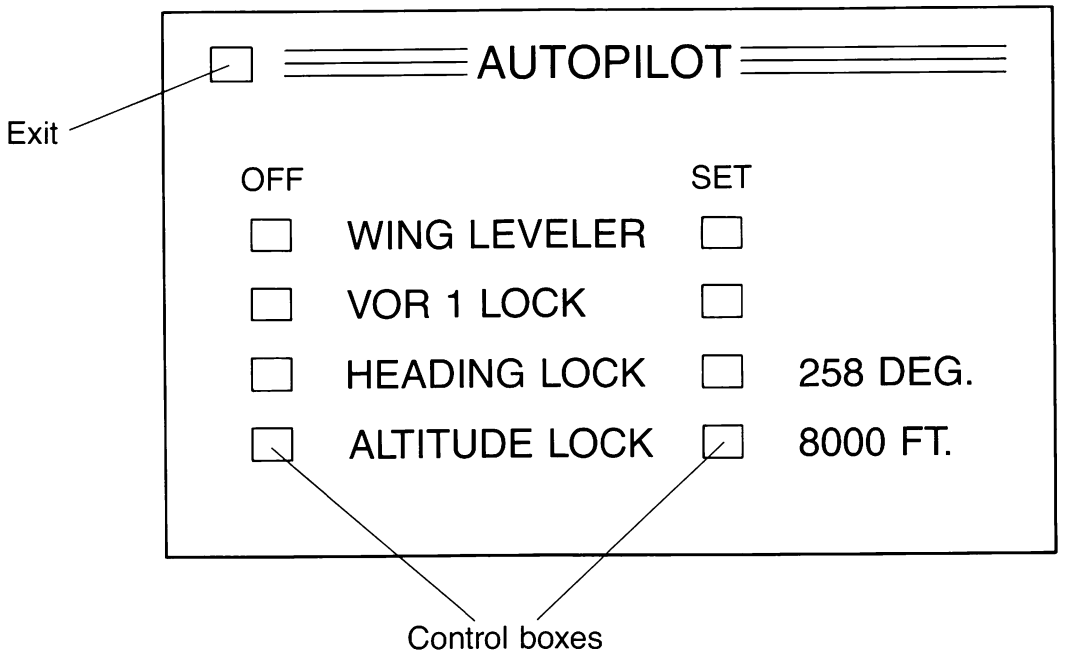


Figure 21. Autopilot Menu

option and turn VOR 1 LOCK on. The autopilot will track the radial while you perform other flight tasks.

Any combination of locks can be on at a time.

Once the autopilot is set, it will start tracking the locked functions. You can turn the autopilot on and off by pressing the [Z] key at any time. The autopilot on/off indicator is located on the control panel (see Reference Figure 1).

Flight controls for the locked functions (ailerons when the wing leveler is turned on, for example) will respond sluggishly as you fight the autopilot. If you need to regain full control for a while, temporarily turn the autopilot off.

SAVING AND RECALLING SITUATIONS

Flight Simulator II allows you to select from a series of prerecorded situations. These include approach to landing, ILS approach, and many others. You can also save a situation while you are flying and start flying from it later by recalling it.

THE SITUATION MENU

Figure 22 shows the situation menu that is selected by clicking on the SITUATION menu bar entry.

SELECTING A PRERECORDED SITUATION

Clicking on the SELECT PRERECORDED menu item activates a dialog box with a list of preset situations. Choose the situation you want to fly in by clicking on it. The simulator will start you off at this situation. From this point on, pressing the [A] key on the keyboard will restart you in this situation.

CREATING AND NAMING YOUR OWN SITUATIONS

If you find yourself in a flight situation you would like to restart from later (a favorite approach, or a strategic navigation position for example), you can save it by pressing the [Q] key. A dialog box will appear and ask you to give the situation a name. This is the new "current" situation, and whenever you press the reset key [A], you will restart from this situation.

The saved situation is available for recall by name at a later time using the RECALL menu option. You can create large menus of situations by saving them and naming them with unique names.

The situations can be saved in two places; RAM (Random-Access Memory), or on a separate disk. Whenever you save a situation, you will be asked which location to save it to. You can build up many situations on disk and/or in RAM.

Saving to disk requires that you insert a writable disk of your own. You will be asked to do this when necessary. This involves a disk swap, but you can build up big situation libraries this way. Saving to RAM is fast and requires no disk swap, but your situations are destroyed when you turn the computer off.

The SITUATION menu contains a few menu editing functions. The LIST option lists all situations in the RAM and on disk by name. DELETE lets you delete situations you no longer need. You will be asked to submit a name to delete.

You can combine the convenience of RAM situations with the advantage of long-term disk storage by using the SAVE RAM TO DISK and LOAD RAM FROM DISK options. Simply use RAM for saving all situations while you fly. When you are done using Flight Simulator II, select the SAVE RAM TO DISK option. All RAM situations will be saved to the disk. When you wish to resume flying, choose the LOAD RAM FROM DISK option to load all situations from the disk into RAM.

IMPORTANT: Never save situations to the Flight Simulator II disk. This disk should always remain write-protected.

INSTANT REPLAY

As you fly, your position is constantly recorded. The last minute or so of flight positions is always stored. You can select the INSTANT REPLAY item on the SITUATION menu to get a visual view of the last few seconds of flight. A dialog box tells you how many seconds of information are available and asks how many you wish to view.

The instant replay is visual only. The instruments don't reflect the flight conditions of the replayed flight. You may change view options such as zoom factor, window size and view direction during instant replay. You may also change window sizes, open new 3D windows or select spot or tower mode.

After the instant replay has been completed, the simulation will pause. To abort an instant replay in progress, select INSTANT REPLAY from the SITUATION menu, then close the dialog box. The instant replay will be aborted, and you will be returned to flight mode with the simulation paused.

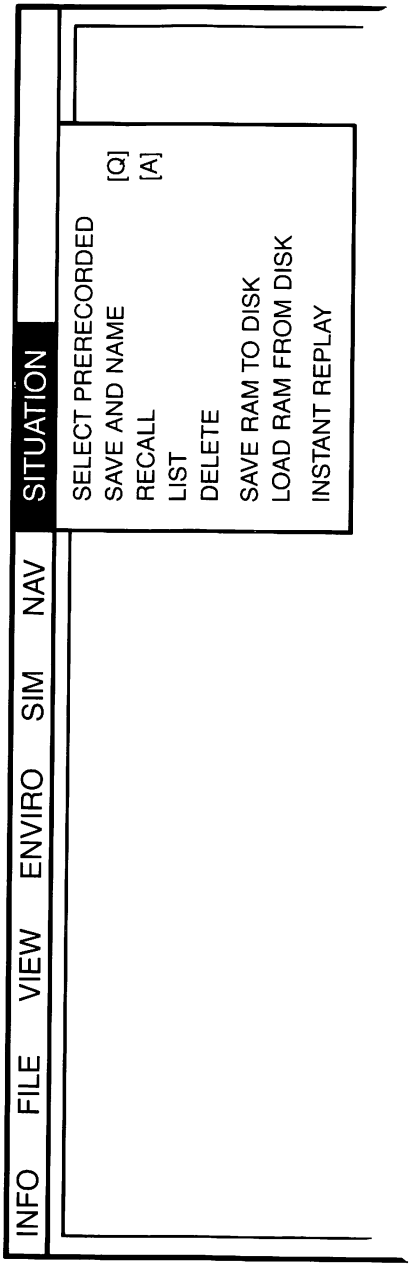


Figure 22. Situation Menu Options

ADVANCED FLIGHT TECHNIQUES

There are a few maneuvers and advanced maneuvers that you can perform in coordinated flight, and even more that can be done in uncoordinated flight. A few of these maneuvers now will be examined.

MANEUVERS AND ADVANCED MANEUVERS

Maneuvers fall into two broad categories: those that make severe demands on the aircraft and put it into unusual attitudes (such as barrel rolls, spins, and loops), and those that use normal flight attitudes but require skill, thought and precision (such as flying a rectangular course in a wind, turns about a point, and eights along a road or around pylons in a wind). Both types of maneuvers are fun, challenging, and help build skills that are useful in every-day and emergency situations.

The FS2 is capable of most maneuvers and advanced maneuvers. There are enough ground reference points to perform ground-reference maneuvers, and the simulated aircraft has the power and airframe strength to do maximum performance flight maneuvers. The editor can be used to set the wind speed and direction to any velocity and angle, thereby adding challenge to ground reference maneuvers. The view selector can be used to view the ground reference points while making turns, but when using this feature, make sure to remember which view direction is selected, and always revert to the front view before going on to other flight tasks.

A good student flight manual such as the *Flight Training Handbook*, publication AC 61-21A (1980 revision) put out by the Federal Aviation Administration can be consulted for details on how to perform the following maneuvers:

1. Turns in the wind.
2. "S" turns across a road.
3. Turns around a point.
4. Eights along and across a road.
5. Eights around and on pylons.
6. Line-of-sight to pylons.

These maneuvers can be performed satisfactorily in auto-coordinated mode as well as coordinated mode.

Many stalls can also be performed in both flight modes.

UNCOORDINATED FLIGHT

Click on AUTO COORD on the SIM menu to disable auto-coordinated flight and make the ailerons and rudder work independently. With auto-coordination disabled it is up to the pilot to coordinate turns using the slip-skid indicator. If you are a pilot, your training has included slip and skid procedures, turn coordination methods and warnings that tell you the dangers of uncoordinated flight attitudes. No further explanations are needed. New pilots, however, may wonder why anyone would ever want to fly without auto-coordination (which is available in partial form on some modern aircraft, and even some older models such as the Wright-Brothers' aircraft). A few good uses for uncoordinated flight will now be presented.

As stated earlier, an aircraft is in coordinated flight when its longitudinal axis is parallel to the direction of flight through the air surrounding it. Coordinated flight is the safest flight attitude. The aircraft is usually in its best aerodynamic position when flying in a coordinated attitude - flying relatively straight through the air (as opposed to flying through air sideways or slightly sideways, with air battering one side of the aircraft leaving one wing in an airflow shadow).

Airplanes turn by banking that occurs when you apply ailerons. While in a bank, your wing's lifting force (which normally points straight up in straight flight) points at the bank angle. Some of the force is distributed in the upward direction as usual, but the remaining force (or component of the vector) points sideways. It's this side force that causes the aircraft to start its turn, or at least to start moving slightly sideways through the air. Incidentally, the lifting force is reduced in the bank (some of the vector results in side-force) and this is why the aircraft tends to loose altitude in a bank.

Once the aircraft starts flying slightly sideways, it is in uncoordinated flight. This is where the rudder comes in. The rudder is used to yaw the plane (cause it to rotate about its vertical axis, from side to side). If the plane is flying slightly sideways due to its bank angle, the rudder can be used to straighten the plane out again relative to the sideways oncoming wind. When rudder is applied, the

flight becomes coordinated again as the aircraft is yawed. The yaw results in a change in heading. The aircraft turns.

Rudder and aileron are applied together when entering the turn to keep the plane in coordinated flight. The slip/skid indicator ball remains centered to indicate that the aircraft is coordinated. If the ball is to the right of center, more right rudder is needed. Similarly, when the ball is to the left of center, more left rudder is needed.

A plane that has too little rudder applied flies through the air slightly sideways. This is known as a slip. If aileron only is applied, a slip results. With the rudder straight and only aileron applied, the aircraft will still turn. Airplanes have good aerodynamics and like to point into the wind, so the plane will "weather-vane" its way around to a new heading to align itself with the flight path and oncoming wind. The result is an uncoordinated turn. There are no good reasons for performing uncoordinated turns and it's a bad habit to get into.

A bit of REVERSE rudder can be applied in a slip to keep the plane from weather-vaning around. This is where a slip begins to become useful. If right aileron and left rudder are applied, the aircraft banks to the right and thus starts moving to the right. The reverse rudder keeps the plane from yawing to a new heading so the plane's body stays lined-up with a straight flight path. This technique can be used to move the plane to the left or right without changing heading. If you happen to be on final approach and are 30 feet from the runway's center, a slight slip can be entered to move you over 30 feet while your plane remains pointing in the runway's direction.

Slips become even more useful when performing crosswind landings. As mentioned earlier, you must land with your airplane pointing straight down the runway. If you land at a slight angle (in a "crab") your wheels will try to throw the plane off the runway. When landing in a crosswind, however, you must fly at a slight crab angle to compensate for the crosswind and to keep you from drifting away from the runway. There are three ways to land in a crosswind. You can make your approach with a crab angle and at the last instant before you touch down "kick it out" of the crab angle. This can be quite dangerous and requires considerable skill to do correctly. The second way is to land on glare ice in a crab angle. Your wheels will simply slide down the runway sideways (hardly a practical solution, but known to work). The practical solution which is most commonly used is to use the slip. The aircraft can be kept aligned with (parallel to) the runway using rudder, and ailerons can be used to increase bank to the point where the airplane is flying sideways at just the right rate to

compensate for the crosswind. The slip can be held all the way down to the landing. This, of course, means you will land in a bank on one wheel. There is nothing wrong with that. Landing on one wheel is part of the crosswind landing technique.

It is important to realize that slips, and any uncoordinated flight, puts extra drag on the aircraft. You will loose altitude faster in a slip than in straight, coordinated flight. This can be put to good use, again on final approach. When you are too high on final approach, a slip can be used to lose some altitude. This practice is very seldom used on modern aircraft, but was used extensively on older planes, especially those without flaps. A slip used to move the plane sideways, as in a crosswind landing, is known as a side slip while a slip used to dissipate altitude without increasing airspeed is a forward slip.

Slips, like any uncoordinated flight, put the aircraft in a bad aerodynamic configuration and can thus be dangerous. It's good to get a feel for what the aircraft is capable of by practicing crossed-control stalls at high altitudes. In this maneuver, you intentionally enter a severe slip or skid until the plane stalls.

When more aileron than rudder is used, a slip results. When more rudder than aileron is used, a skid is produced. Skids are of little use and are quite dangerous because they tend to cause the inner wing to stall, thereby putting you into a spin or spiral in the direction of your current bank. Severe slips can also stall a wing but they tend to bank you in the opposite direction which tends to correct the problem. A skid immediately increases the problem and can roll you so fast that the bank may be vertical or past vertical before it can be stopped.

INSTRUMENT FLIGHT

The FS2 simulator has enough instrumentation, and the "world" has enough VORs, airports, ILS systems, marker beacons, and NDBs to practice IFR flight and approaches. Instruments include two NAV radios and VOR indicators, glide-slope indicator, ADF receiver and bearing indicator, DME, and Inner marker, Middle marker, and Outer marker lights.

The subject of instrument approach techniques is outside the scope of this manual. If you are not an instrument-rated pilot, details of instrument approaches and flying can be found in training manuals such as *Instrument*

Flying by Richard L. Taylor (Macmillan Publishing Co., Inc. 1978). Flight Simulator II is a good aid in getting familiar with instrument approaches and nicely supplements a training manual.

Instrument approaches are available at many of the airports included with FS2. Approach information that includes approach-in-use, localizer frequency, and other relevant items can be heard by tuning in ATIS on the COM radio (ATIS frequencies appear on the charts). This information scrolls across the screen above the 3D display at a rate that can be set using the editor. The ATIS information is a combination of information that would normally be given by ATIS, approach control, tower, and approach plates. If no ATIS is available at the airport, tune in the indicated common traffic advisory frequency.

Instrument approach aids (ILS, beacons, etc.) are patterned after approaches found in *United States Government Instrument Approach Procedures* (standard approach plates). These approach plates can aid you in practicing approaches.

WORLD WAR I ACE

WW I Ace is a 3D aerial battle game that involves bombing runs and dog-fights with the computer-controlled enemy. Figure 23 shows the battle area and its features.

STARTING THE GAME

To start the game, select WWI ACE from the FILE menu. This switches to the battlefield shown in Fig. 23. You will be sitting on the runway of Airbase 2. You are fueled, armed, and ready to go. A truce is in effect and hostilities won't begin until you declare war by pressing the [Shift][W] keys. You can therefore go on a scouting mission to look over the enemy's territory. You needn't be at your airbase to declare war, and may find it more strategic to be elsewhere when doing so.

GOAL

The enemy occupies the territory west of the river. They have established two airbases, a fuel depot for each, and a few factories. Your commander has instructed you to bomb the fuel depots and factories.

Your mission, however, is complicated by six enemy fighters stationed at the airbases. These fighters will protect the fuel depots and factories. Your mission is also to shoot down as many enemy fighters as possible.

WWI ACE CONTROLS

The same basic aircraft controls are used in both WWI ACE and regular flight mode. The following controls are added to control the armament features:

World War I Ace Control Summary

Key	Function
[Shift][W]	Declare war
[Shift][X]	Drop bomb
[Shift][E]	War report
[space bar]	Machine guns

FIGHTING THE FIGHTERS

The basic way of fighting a fighter is to get close to one, point straight at it, and fire your machine guns. The [space bar] is the gun trigger and rapid bursts of many shots are needed to be effective. You have a probabilistic chance of hitting an enemy if he is within your gun's sights and range, but the distance you must be from the enemy decreases rapidly as the enemy moves to the sides of the sights. The guns have good straight range, but poor side range.

Every enemy fighter has a different flying technique. The enemy pilots have orders to intercept any invader, but each fighter pilot has different instructions concerning when to launch and when to return back to base. The pilots are of different skill levels. Some take a long time to successfully hit you, while the Aces are very proficient and score quickly.

Fighter planes as well as pilots are different from one another. There are two fast, rugged fighters with unreliable guns, one plane with good speed and maneuverability, one reliable fighter with average speed, maneuverability, and guns, and two super fighters. These planes all have different climb rates and cruise performance. Count on the Aces to be in the best planes.

FIGHTER MODE INSTRUMENTATION

The instrument panel is augmented with fighter aircraft instrumentation when playing WW I Ace. The multipurpose instrument panel area (the radio stack

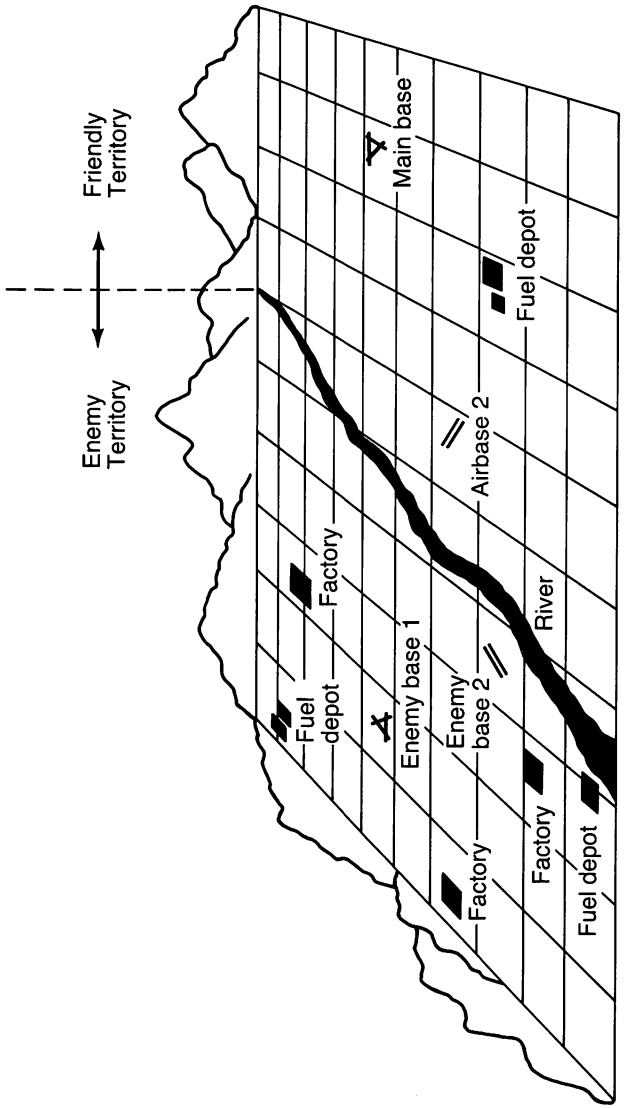


Figure 23. WWI Ace Battleground

area) goes into its attack-radar mode. In this mode, a small airplane outline appears at the screen's center and the position of enemy fighters around you is shown. The upper line of the attack-radar screen flashes status messages indicating important war events.

USING RADAR

World War I aircraft had no radar, but the FS2 does. This radar is available to compensate for viewing restrictions of the 3D screen. The radar picks up enemies around you. The small plane in the center of the radar represents your position and orientation, and enemy aircraft are represented by dots on the screen. This radar has approximately a 1-mile radius range.

BOMBING

The fuel depots and factories are the targets. There is only one load of five bombs, so you can destroy a maximum of five targets per mission. Refueling at Base 1 automatically reloads new bombs. Base 2 only has fuel.

The downward view includes a bomb sight in war mode. This is used to aim at the target. The [Shift][X] keys drop a single bomb.

GETTING SHOT DOWN

The enemy can shoot you down. Every hit that the enemy gets degrades the performance of your aircraft. Note that a shooting enemy doesn't necessarily score. Hits depend on the enemy pilot's skill level. If your aircraft is damaged (acting strangely, losing fuel, or oil pressure dropping), try to make it back to the base for repairs and refueling.

BECOMING AN ACE

You must down at least five enemy aircraft to become an Ace. Extra points will bring you other honors. Points are issued as follows:

Points	Action
1	Downing an enemy aircraft (depending on aircraft and damage inflicted).
4	Bombing a factory.
2	Destroying a fuel depot.

There are only 6 enemy fighters spread between the two enemy airbases. Enemy aircraft are replaced while you are at your base.

MULTI PLAYER

The MULTI PLAYER option from the FILE menu enables two or more players using separate machines to fly together. Communication between machines is through the ST's modem port. You may communicate with any machine which runs FS2 and supports the multi-player option, so long as you have a compatible cable to connect the machines together. (NOTE: In order for more than two players to fly together a host program is necessary. Documentation specific to setting up for more than two players is included with the host program documentation.)

CONNECTING TWO MACHINES TOGETHER

If you will be communicating between two computers in the same room, you can connect them together using SubLOGIC serial cables. These cables may be ordered directly from SubLOGIC. (See the enclosed order card for more information.) Once you have obtained these cables, making the connection is simple. If the connection is between two Atari ST's, the cables will be identical. Plug the DB25 ends (rectangular ends) of the cables into the ST modem ports. Then connect the RCA plugs together, inserting the male plug from one cable into the female plug on the other. Do the same for the other pair of plugs so that all four RCA plugs have been connected. This completes the connection. You are now ready to continue with multi-player.

If you will be using two modems for communications, you can connect one directly to the modem port of each Atari ST computer using standard modem cable. You do not need to obtain a SubLOGIC serial cable.

If you prefer, you can use your own cable. For the Atari ST or Amiga, any null modem cable will work so long as you have the proper connectors on the ends. (See Figure 24.) If both machines are Atari ST's, the DB25 connectors must be female. A null modem cable is a cable in which lines 2 and 3 have been crossed, with all other lines passing straight through. For multi-player communications it is only necessary that lines 2,3 and 7 be connected, but it is all right if all other lines pass through.

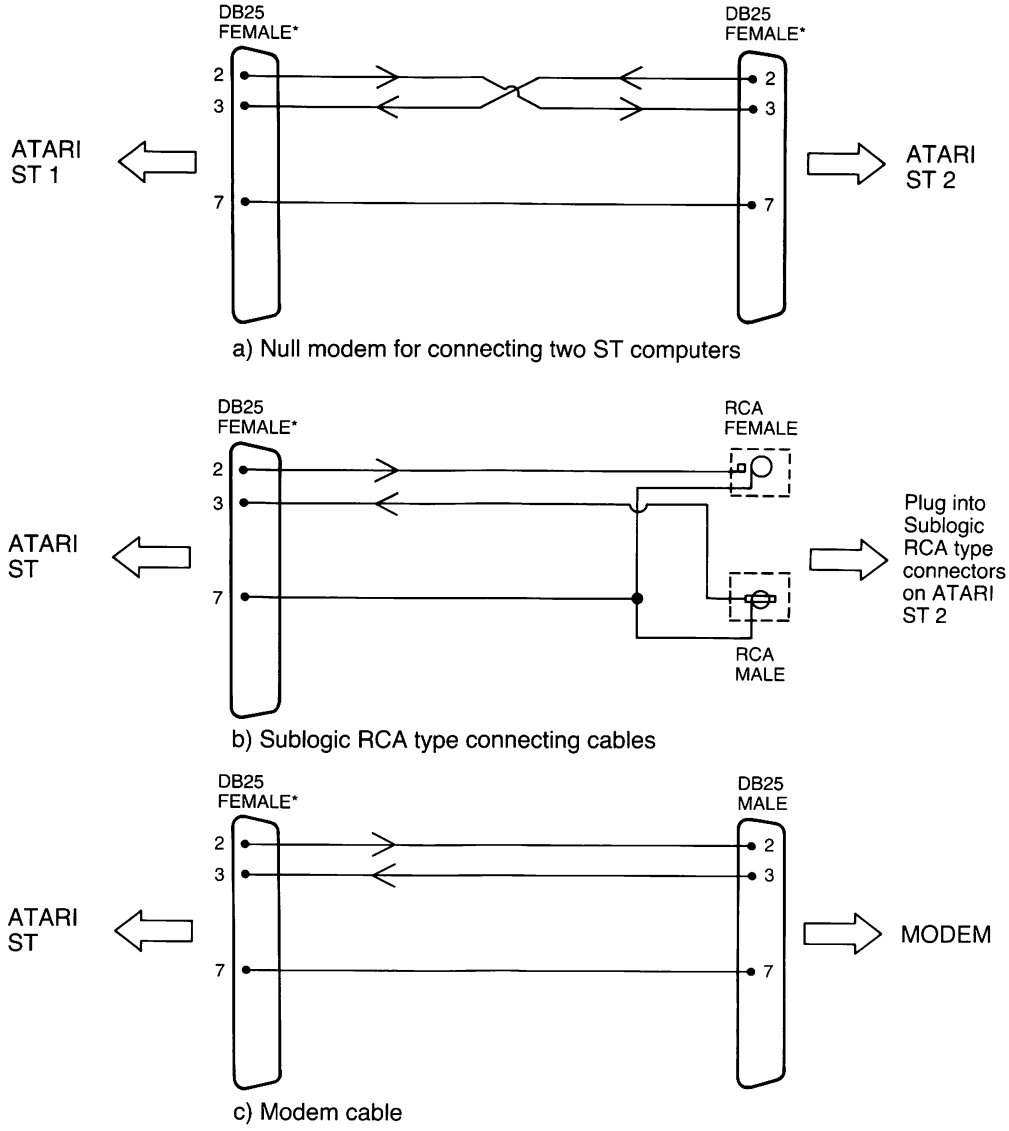
ESTABLISHING A CONNECTION BETWEEN MODEMS

If you will be communicating through modems, you must first make a telephone connection. You can do this entirely within the FS2 program. From the menu bar, click on FILE to bring up file options and then select MULTI PLAYER. Select baud rate by clicking on the appropriate box on the right side of the menu. You will probably want to use 300, 1200 or 2400, depending on what baud rates your modem can handle. Make sure the other player will be communicating at the same baud rate. Now, one of you must make the phone call and the other must answer it.

If you are both using Hayes-compatible modems, use the following procedure. The person answering need only click on the WAIT FOR RING box and wait for the phone call to come through. The person making the call may click on the DIAL box and then enter the phone number in the message box which will come up. (Note that there is a ">" symbol to the left of the message line. This signifies that characters will be sent to the modem, rather than to the other player. More on that later.) Press [Return] to make the phone call. If all goes well the number will be dialed and, when a connection has been established, the message "CONNECT" will be displayed on the bottom line of the message box. This means that the computers are ready to communicate. Now both players must click on the ON-LINE box to begin multi-player communications. This tells FS2 to begin sending information (such as coordinates) between machines. It also disables the modem echo feature which displayed the "CONNECT" message earlier.

If you are not using a Hayes-compatible modem, the DIAL and WAIT FOR RING options may not work for you. In place of these, click on the MESSAGES/TALK TO MODEM box to talk to the modem. A message box will come up which will accept text to be sent either to the modem or the other player. In order to talk to the modem, enter ">" as the first character. Then, after pressing [Return], all characters entered on that line will be sent to the modem rather than to the other player. You will also be removed from ON-LINE mode so that information such as coordinates will not be sent. Also, incoming characters will be echoed to the bottom line of the message box so you will know what your modem is saying. Consult your modem documentation to see how to establish a phone connection between machines. After you have done that, click on ON-LINE to begin multi-player.

At any time, you can send a command to the modem by bringing up the message box and entering ">" as the first character. This instructs FS2 to send



*AMIGA Users Note: These pinouts are applicable for the AMIGA, but use a MALE DB25 plug.

Figure 24. Multi-Player Cable Connections

the line to the modem, rather than to the other player. Remember that it will also remove you from ON-LINE mode, so that you will have to click on ON-LINE to return to multi-player communications.

Note that when you are "talking" to your modem, all incoming characters will be echoed to the bottom line of your message box. If the other player is sending you information, this will also be echoed there. It might appear as garbage. This does not mean that anything is wrong.

DIRECT CABLE CONNECTIONS

If your computers are connected using a direct cable (that is, without modems), use the following procedure to establish communications.

From the menu bar, click on FILE to bring up file options and select MULTI PLAYER. Choose your baud rate by clicking on the appropriate box on the right side of the menu. It is best to communicate at the highest baud rate the machines will support, so response will be quick. If both machines are Atari ST's, both players should select 9600 baud. Next, click on the ON-LINE box to begin communications. This tells the FS2 program to begin sending coordinate information between machines.

Note that although baud rates of 38400 and 57600 are listed, they are not selectable. They are listed in case future Atari ST's support these higher baud rates. A baud rate of 19200 is supported, but is not reliable. It is best to limit baud rate to 9600.

MULTI PLAYER FLIGHT

Once you have established communications, you are ready to begin multi-player flight. Place your planes so that they will be visible to each other. The north and east coordinates of the other player's plane will appear in the MULTI PLAYER dialog box at the bottom of your screen, next to OTHER PLAYER COORDS. You can set your own coordinates to these values, or near these values, using the POSITION SET menu. Once you have placed your planes near each other, click on SEND AIRCRAFT to send the model of your plane to the other player,

and have him do the same for you. Although you will be receiving coordinate information, you will not see his plane until you have received his model.

Once you have set your aircraft to the same area and sent aircraft models, you should be able to find the other plane. The easiest way to do this is by using the multi-player track option. In multi-player mode, track mode has a different function. Instead of tracking your own plane from a movable tower, it tracks the other player's plane from your aircraft. This is very useful for finding the other plane, when you think it is near you but aren't sure in which direction to look. Select track mode now by pressing the [D] key. Your view direction might change, and the other airplane should be visible. If it's very small, zoom in (press [F10]) for a closer look. This track feature can be used at any time in multi-player flight to keep track of the location of the other plane, but if you are flying your own plane while in track mode, be careful; your view might not be the view straight out of the cockpit!

Other than the difference in track mode, all FS2 features are available and function the same in multi-player as in regular flight.

SENDING AND RECEIVING MESSAGES

You may send messages to the other player by clicking on the MESSAGES/TALK TO MODEM box on the MULTI PLAYER menu. When you do so, a message box will appear which will accept text to be sent to the other player. When you bring up the message box, all characters typed will be directed there, and will NOT have any effect on your flight, such as aircraft or view control. You can switch from entering message text to controlling your airplane by pressing the [F5] key. This will cause all keys to have their normal effect. It will also make the message box cursor disappear to indicate that keys have their normal function. To return to message mode, press the [F5] key again. The cursor will reappear, and keypresses will be directed to the message box.

To send your message, press [Return]. The message will be sent to the other player and the top line of the message box will be cleared. You may enter another message if you like, or you may close the box to exit message mode. If you are entering a very long message, it will be sent in pieces as you overrun the message box. The message box can accomodate 49 characters, so after you

type your 50th character, the first 49 characters will be sent and your message line will be cleared so you can continue entering text.

Messages received from the other player will be displayed on the bottom line of the message box. If you receive a message from the other player while your message box is not active, it will be brought up automatically for you. If you want to respond to the message, you can do so in the normal way, or you can merely close the box after reading the message.

OTHER MULTI PLAYER OPTIONS

The MULTI PLAYER menu includes an option to change your airplane's fuselage color. After doing so, if you want your opponent to see the new color of your airplane, you must re-send your airplane model (by clicking on SEND AIRCRAFT). Your new fuselage color will be visible to you immediately if you look at your airplane from an external view (SPOT or TOWER mode). Also, if you select a different aircraft type (JET or PROP) and you want the other player to see it, you must re-send your model. Because it can take a while to send an aircraft model (up to one minute at 300 baud), and other information such as airplane coordinates can't be sent during this time, it is a good idea to not send the aircraft model unless necessary.

If you raise or lower your landing gear, this information is automatically sent to the other player, just as your coordinates are constantly being sent.

To exit multi-player mode, click on the QUIT MULTI PLAYER box on the MULTI PLAYER menu. If your connection is through a modem, you might want to disconnect the phone first, by sending a message to the modem using the MESSAGES/TALK TO MODEM option.

SUGGESTIONS FOR MULTI PLAYER FLIGHT

Because an airplane is relatively small and the field of view comprises only a small portion of 3D space, it may at first be difficult to find and keep track of the other player's plane. This becomes easier with practice. In the meantime, there are some features of FS2 that can be used to make it easier.

The most useful feature for keeping track of the other player's plane is the multi-player track mode (activated by pressing the [D] key). This will always point your view in the direction of the other player's plane. Observing the scenery in the background of the other plane can help you determine where the other plane is located with respect to your aircraft. If another 3D window is active and is showing the view from your cockpit, it will not be too difficult to fly towards the other plane when it gets far out of range. Exciting views can be generated in track mode by flying by and around the other plane.

For a demonstration of how effective the track display can be, try setting a large cockpit view in the main 3D window and a smaller track view in the second 3D window. (You may want to slide the panel down a bit to make more room.) Move the second 3D window to a corner of the main 3D window so it will not obscure too much of the cockpit view. Zoom in tight enough on the track display so that the other player's plane is clearly visible. Now as you fly, the other plane will always remain in sight. As you get near the other plane you will get exciting, dynamic views in the track window. It might be useful to fully zoom out (to .25 zoom factor) on your cockpit view to make it easier to find things.

It is also helpful to agree to fly within a relatively small area with recognizable landmarks. For example, the Chicago database contains the John Hancock Building and the Sears Tower, two large buildings which are easily findable from the air. If flying is kept within this area, it will always be easy to find the other plane, particularly by using these landmarks as a guide. You can send messages (such as "I'm circling the Sears Tower!") to help the other player find you. The map display can be helpful in locating landmarks if you get too far away.

One problem in finding the other plane is that, in addition to being in any direction around you, he might also be at any altitude above or below you. By having both players enable autopilot and set altitude lock to the same level, the autopilot will do a good job of maintaining a fairly steady altitude as long as you don't get too aerobatic. Then you can concentrate on just looking left and right to find the other player. It can also be useful to bank fairly hard, fly in a circle, and look for the other plane to come into view. Again, zooming way out on the cockpit display will be helpful.

SLEW mode and POSITION SET can also be useful in bringing your planes together, both initially and when they stray too far apart. If you get too far ahead of the other player, you can pause ([P] key) your simulation for a bit to

let him catch up. You might also want to disable crash detection (under REALISM in the SIM menu), because it is easy to get so wrapped up in searching for your partner that you forget about the location of your own aircraft.

Once you are adept at finding each other in a local area, it shouldn't be too hard to stay in contact in a wide open area on a cross-country flight. The fine view adjustment controls (the cursor keys) can be used to keep the other plane in sight, much as a passenger on a plane would turn his head to view the scenery as it passes by. And watching the other plane do aerobatics can be particularly enjoyable, a sort of do-it-yourself airshow!

APPENDIX I - REFERENCE FIGURES

The Standardized Instrument Cluster

1. Airspeed indicator (knots)
2. Attitude indicator (artificial horizon)
3. Altimeter (feet)
4. Turn coordinator with slip/skid indicator
5. Heading indicator (directional gyro)
6. Vertical speed (rate of climb) indicator

Other Instruments and Indicators

7. Magnetic compass
8. Omni-Bearing Indicator with glideslope (NAV 1)
9. Omni-Bearing Indicator (NAV 2)
10. Clock
11. Outer, Middle and Inner marker lights
12. Left wing fuel tank gauge
13. Right wing fuel tank gauge
14. Oil temperature gauge
15. Oil pressure gauge
16. Tachometer

Radios

17. NAV 1 radio
18. NAV 2 radio
19. Distance measuring equipment (DME)
20. Automatic direction finder (ADF)
21. COM radio
22. Transponder

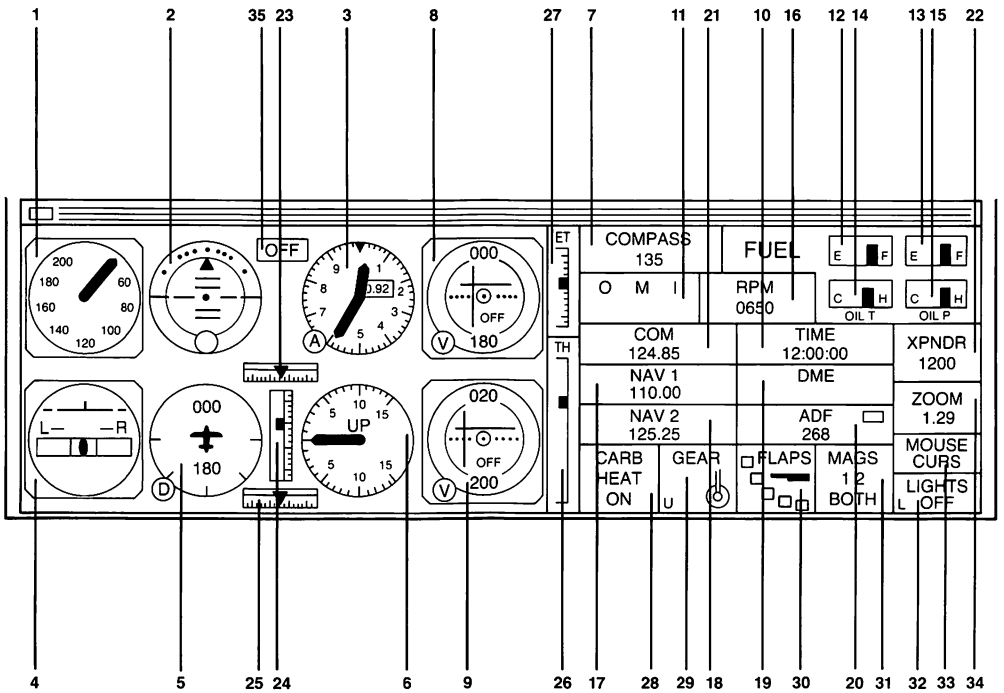
Control Position Indicators

23. Aileron position indicator
24. Elevator position indicator
25. Rudder position indicator
26. Throttle position indicator
27. Elevator trim indicator

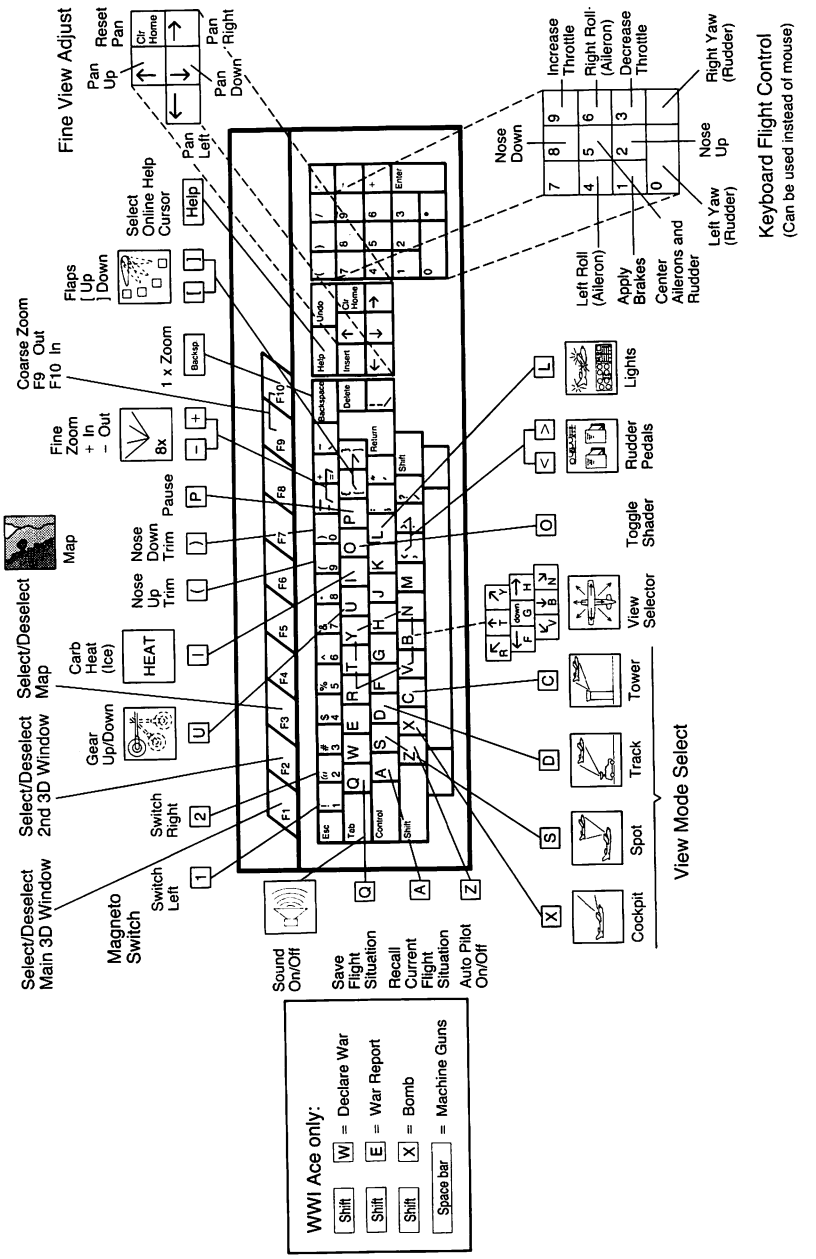
Reference Figure 1. Instruments

Indicator/Control Icons

28. Carb heat on/off
29. Landing gear up/down
30. Flap position setting
31. Magneto switch position
32. Lights on/off
33. Mouse Cursor/Yoke mode setting
34. 3D primary window zoom factor
35. Autopilot on/off



Reference Figure 1. Instruments



Reference Figure 2. Keyboard Controls

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